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BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 84, No. 1, pp. 1–8 JANUARY, 1957

FURTHER EXPERIMENTS WITH MALE AND FEMALE GRAFTS OF MERCURIALIS ANNUA

CECIL YAMPOLSKY

The results of grafting male and female plants of *Mercurialis annua* published in 1930, show that equally vigorous males and females in the roles of scion or stock, continue the production of male or female flowers without any obvious influence of one sex upon the other sex. The transferance of elaborated substances from the scion down to the stock and the movement of substances from the stock into the scion, did not at any time, alter the sex expression of the component elements of the graft. It was concluded that male and female elements can live together in the same graft without mutually influencing their morphological expressions. It also was concluded that hormonic substances, if there be such substances in plants, were unable to pass the barrier between stock and scion, or if they did pass from the male elements of the graft into the female elements, they were rendered innocuous.

The mounting emphasis upon the significance of auxins in plant metabolism, strengthened the urge to pursue the investigation further. *Mercurialis annua* has been used as an experimental object for many years. Historically interesting is the fact it was this plant that yielded experimental evidence that pollen and fruit setting are correlated (Camerarius). This Euphorbiacious plant, described as imperfectly dioecious, expresses sex in endless graded forms as well as in obligate maleness and femaleness.

When plants are but a few weeks old, male or female flowers appear in daily successions, and in increasing numbers, until the maximum vigor and growth of the plant have been reached. And even, with the decline of the plant, flowers are produced to the very end. The male flowers are borne in interrupted spikes which surpass the leaves; the female flowers as a rule, are sessile, and are borne in the axis of the leaves. There is no difficulty in distinguishing between a male and female plant. This intergradation alluded to, may exhibit itself in the sex reversal of an entire plant or in graded transformations of stamen into pistil or pistil into stamen (Yampolsky 1934).

Mutilation of plants at the height of their vigor, may force a sex alteration (Yampolsky 1930). In *Mercurialis annua* the balance may be caused to shift its position by natural or induced conditions, and therefore it was deemed desirable to pursue the investigation further under altered relationship between stock and scion.

[THE BULLETIN for November–December 1956 (83: 403–464) was issued February 22, 1957.]

Vigorous males and vigorous females as partners in a graft, yielded negative results. How would stocks and scions react if they were of unequal vigor? With that question in mind, seedlings were raised and potted, two plants in each pot, one male and one female. When they were about four months old grafts were made as follows:

Group I male plants and female plants of equal vigor and size—15 grafts
Group II male plants and female plants of unequal vigor and size, the males the more vigorous and larger—15 grafts
Group III male plants and female plants of unequal vigor, the female plants the more vigorous and larger—15 grafts

Grafting by in-arching was found to be very satisfactory and highly successful. Severance of the root system from the scion elements of the grafts was accomplished gradually. Seven grafts in each of the three groups were allowed to produce branches, leaves and flowers on stock and scion. Only when one of the elements of the graft tended to outstrip the other, was judicious pruning used.

The remaining eight grafts in each of these groups were treated alike, the stocks were prevented from developing branches throughout the experiment. Whatever photosynthetic activities took place in the stock, was limited to the chlorophyll bearing cells of the stock.

Some plants were discraded when grafts were seven months old, others lingered on for several months more. The female elements of the grafts when allowed to develop produced abundant fruit and seed. The male elements of the graft when allowed to develop, produced profuse numbers of male flowers.

Observations. Group I, Plants of equal vigor and size. Seven grafts, three with female stocks and male scions, four with male stocks and female scions showed no sex reversal. Female scions produced abundant fruit and seed. Eight grafts—scions alone allowed to develop. The four male scions produced profuse numbers of male flowers; the four female scions produced abundant fruit and seed. *No sex reversal.*

Group II, Plants of unequal vigor and size, the male plants the superior. Seven grafts, three with female stocks and male scions, four with male stocks and female scions. The female scions produced abundant fruit and seed. Eight grafts, scions alone allowed to develop. The male scions produced profuse numbers of male flowers; the four female scions produced abundant fruit and seed. *No sex reversal.*

Group III, Plants of unequal vigor and size; the female plants the superior. Seven grafts, three with female stock and male scions, four with female stocks and female scions. The female scions produced abundant fruit and seed. Eight grafts, scions alone allowed to develop. The four male scions

produced profuse numbers of male flowers; the four female scions produced abundant fruit and seed. *No sex reversal.*

The results of these experiments substantiate the results published in 1930. Movement of materials from the stock into the scion and from the scion into the stock failed to modify the sex expression of the component elements of the graft.

When the first graft experiments were made, Manoiloff (1924) had maintained that chlorophyll extracts from male and female plants gave positive tests for sex differentiation. Satina and Blakeslee (1926) substantiated Manoiloff's contention. The negative results obtained in the grafts of male and female *Mercurialis annua* plants, questioned the presence of hormonic substances in the tissues as postulated by Manoiloff and Satina and Blakeslee. If there be any validity in the hormonic theory of sex, or if the elaborated substances of the male and female are distinct, then a co-mingling of such substances should show a mutual influence either on the physiologic or the morphologic expression or on both. Strasburger (1901) has shown that protoplasmic connections are established between the stock and scion of a graft. Thus materials pass up and down the plant without hindrance. The recent contention of Lysenko (1946) that using Michurin's method of mentor genetic properties may be transferred from scion to stock so that the new stock can transmit those properties, is not an isolated case. Arakian and Jastreb (1941) state that they obtained hereditary transmission of color through vegetative hybridization of tomato grafts. The F2 offsprings showed the characteristics acquired through grafting. Von Wettstein and Pirschle (1938) record a transference of gene determined substances in a Petunia graft. Dawson (1942) found a small amount of nicotine in the tomato stem and larger quantities in the leaves of tomato-tobacco grafts.

The results obtained from the three groups of grafts are at variance with the investigations that show a definite modification by one of the partners of the graft. Scion and stock of equal vigor and scion and stock of unequal vigor showed no mutual influence. How would a greater inequality between male and female affect one or the other? For this experiment male and female plants of equal vigor were potted as follows:

1) one male and one female—Plate I, figure 1 and 3–12 successful grafts
2) one female between two males—Plate I, figure II, 15–8 successful grafts
3) one male between two females—Plate I, figure 9, 13–8 successful grafts

When the plants were about four months old and had established themselves in 8 inch pots, they were ready for the experiments. The lower

branches were removed to allow for better manipulation of the stems which by this time, were conveniently close for grafting by inarching. With a razor blade 1½–2 inch strips were removed and the exposed surfaces brought together and taped. The taped areas were further reinforced by winding raffia strands about them. Bamboo scaffolds to lend support to the plants, particularly to the scion after severance from the root system, were found to be practical and reduced the number of mishaps due to rupture of

TABLE. 1. *Partners in graft four months old at start of experiment.*

Graft No.	Kind of graft	Date of graft		Length of time of observation		Result		
1.	male-female-stock	April	to Sept.	6	months	no sex		modification
2.	male-female-stock	"	" Aug.	5	"	"	"	"
3.	male-female-stock	"	" "	5	"	"	"	"
4.	male-female-stock	"	" "	5	"	"	"	"
5.	male-female-scion	"	" "	5	"	"	"	"
6.	male-female-scion	"	" "	5	"	"	"	"
7.	male-female-scion	"	" "	5	"	"	"	"
8.	male-female-scion	"	" "	5	"	"	"	"
9.	2 males-1 female-scion	"	" July	4	"	"	"	"
10.	2 males-1 female-scion	"	" Aug.	5	"	"	"	"
11.	2 males-1 female-scion	"	" Sept.	6	"	"	"	"
12.	2 males-1 female-scion	"	" mid. Aug.	5½	"	"	"	"
13.	2 males-1 female-scion	"	" " "	5½	"	"	"	"
14.	2 females-1 male-scion	"	" Sept.	6	"	"	"	"
15.	2 females-1 male-scion	"	" "	6	"	"	"	"
16.	2 females-1 male-scion	"	" " " July	4½	"	"	"	"
17.	2 females-1 male-scion	"	" Sept.	6	"	"	"	"
18.	2 females-1 male-scion	"	" Aug.	5	"	"	"	"
		Chain grafts						
19.	2 males-1 female	April	to Sept.	6	months	no sex		modification
20.	2 males-1 female	"	" Aug.	5	"	"	"	"
21.	2 males-1 female	"	" "	5	"	"	"	"
22.	2 females-1 male	"	" "	5	"	"	"	"
23.	2 females-1 male	"	" Sept.	6	"	"	"	"
24.	2 females-1 male	"	" Aug.	5	"	"	"	"
25.	male-female-2 junctures	"	" "	5	"	"	"	"
26.	male-female-2 junctures	"	" "	5	"	"	"	"
27.	male-female-2 junctures	"	" Sept.	6	"	"	"	"
28.	male-female-2 junctures	"	" "	6	"	"	"	"

healed areas. In June the grafts were removed from the greenhouse and grown in the open, under uniform conditions of soil and moisture.

Grafts 1–8. Table 1, Plate I, figures 1–4, male-female grafts—four female sections with male stock and four male scions with female stocks. The branches of both stock and scion were allowed to grow freely.

Grafts 9–13, Table 1, Plate I, figures 15, 16—male-female-male graft. The scion in this case female, received elaborated substances from two male stocks. These stocks were allowed to produce branches and male flowers in profusion.

Grafts 14–18—Table 1, Plate I, figures 13, 14—female-male-female

grafts. The scion in this case, male, received elaborated substances from the female stocks. These stocks were allowed to produce branches and female flowers in profusion.

Grafts 19–21, Table 1—male-female-male chain graft (Plate I, figures 11, 12). In this graft the root systems of one male and a female were severed from the plants and the crown removed from the second male plant serving as stock. Thus the male stock is attached to a female intermediary element, which in turn, is attached to a male scion. The intervening female element receives water and soluble substances through the male stock and passes them on to the uppermost portion, male scion. In turn substances pass down from the male scion into the intervening female element, which in turn sends substances into the male stock. Branches and flowers on all three were allowed to develop freely.

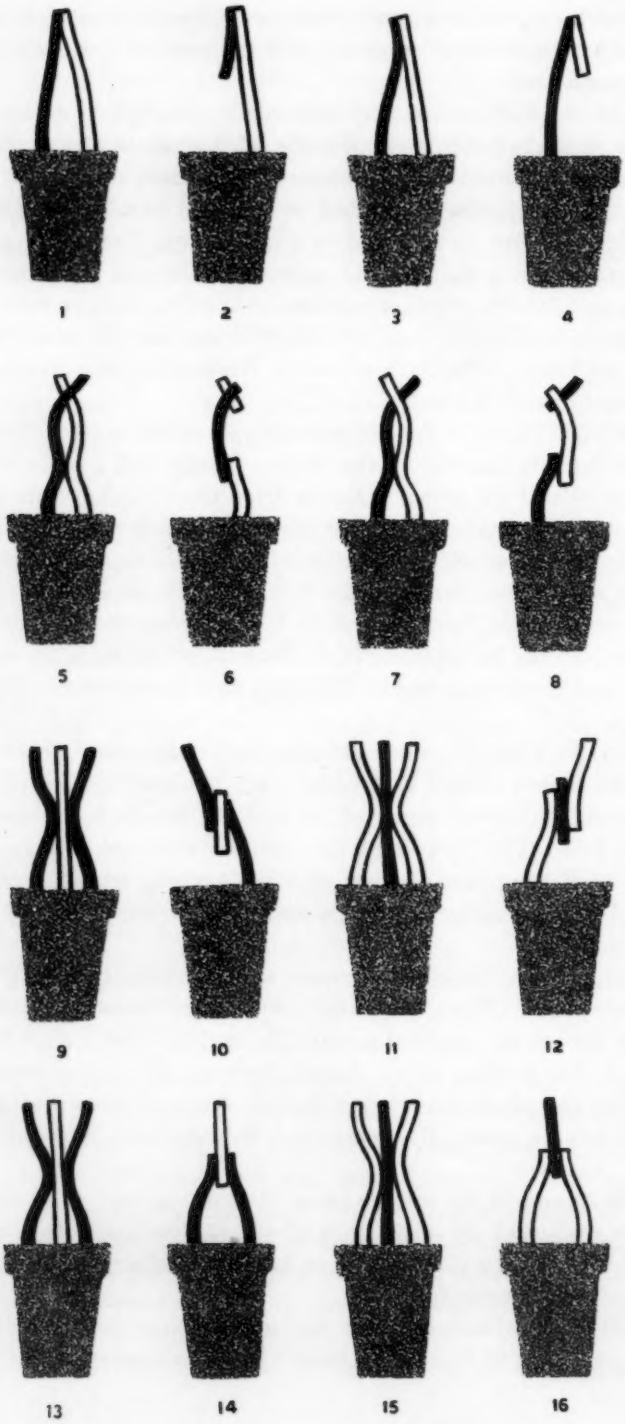
Grafts 22–24, Table 1—female-male-female chain graft (Plate I, figures 9, 10). In this graft the root system of one female and a male were severed from the plants and the crown removed from the second female plant. Thus the female stock is attached to a male intermediary element which in turn is attached to female scion. The intervening male element receives water and soluble substances through the female stock and passes them on to the uppermost portion, female scion. In turn substances pass down from the female scion into the intervening male element, which in turn, sends soluble substances into the female stock. Branches and flowers were allowed to develop freely.

Grafts 25–26, Table 1—one male and one female chain graft. Plants are joined at two points (Plate I, figures 5, 6). The root system of the female was severed and the crown removed, so that the female is represented by an intervening piece. The portion of the male between the two junctures was removed so that the plant consists of a male stock, an intervening female portion and a male scion. Branches and flowers were allowed to develop freely.

Grafts 27 and 28, Table 1—one male and one female chain graft. Plants joined at two points (Plate I, figures 7, 8). The root system of the male was severed and the crown removed so that the male is represented by an intervening piece. The portion of the female between the two junctures was removed so that the plant consisted of female stock, an intervening male portion and a female scion. Branches and flowers were allowed to develop freely.

In grafts 25 and 26 the middle piece (female) served as an intermediary between the stock and the scion both of which were male. In grafts 27 and 28 the middle piece (male) served as an intermediary between stock and scion both of which were female.

The grafts were examined every day at first, and later every three days. When vigorous growth had set in more time was consumed for each graft.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Profuse setting of seed occurred. Judicious pruning had to be practised to prevent one element of the graft from overwhelming the other element. Table 1 shows the negative character of the results; there was no evidence of sex reversal.

With the completion of the last experiment a total of more than 150 grafts had been kept under observation without a single instance of unilateral or mutual influence of stock upon scion or scion upon stock.

The stability of the components of the grafts in the experiments begun in 1929 and the subsequent ones, are at variance with the behavior of *Mercurialis annua* under normal conditions where intersexuality is so widespread (Yampolsky 1934). Decapitation of male plants at the height of vegetative and reproductive vigor, creates an unbalance so that many of the new branches produce besides male flowers, varying numbers of female and hermaphrodite flowers. On the other hand those decapitated branches when rooted, develop into male plants with no evidence of sex reversal.

So-called graft hybrids in plants present a unique morpho-genetic problem. The Solanum-Lycopersicum grafts of Winkler's (1910) demonstrated an adjustment between two sets of tissues of different hereditary potentialities. Cell complexes in contact with cell complexes of different genetic constitution, produce a functional, physiological and morphological entity, yet neither cell complex Solanum nor Lycopersicum abdicates its hereditary individuality.

The transference of substances from stock to scion and from scion to stock in *Mercurialis* must be an accepted fact as it is in all grafts. In the first series of grafts (1930) where the vigor of the scion matched that of the stock, neither element of the graft was influenced by whatever elaborated substances a particular sex produced. It was then concluded that the re-

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FIGS. 1–16. Black—female element of graft; white—male element of graft. 1. Union of male and female plants. 2. Root system severed from scion (female). 3. Union of male and female plants. 4. Root system severed from scion (male). 5. Union of male plant and female plant at two points. 6. Root system of female severed—remaining portion attached to male at two points. Portion of male between the regions of attachment removed—male plant both stock and scion yet separated—communication by way of the intervening female element of the graft. 7. Union of male plant and female plant at two points. 8. Root system of male severed—remaining portion attached to female at two points. Portion of female between the regions of attachment removed. Female plant both stock and scion yet separated; communication by way of the intervening male element of the graft. 9. Union of two female plants and one male plant. 10. Root systems of one female plant and male plant severed. The crown of the other female plant removed (stock). Graft consists of female stock, intervening male portion and female scion. 11. Union of two male plants and one female plant. 12. Root systems of one male plant and one female plant severed—The crown of the other male plant removed (stock). Graft consists of male stock, intervening female portion and male scion. 13. Union of two female plants and one male plant. 14. Rot system of male plant severed (scion) crowns of the two female plants removed (2 stocks). 15. Union of two male plants and one female plant. 16. Root system of female plant severed (scion)—crowns of the two male plants removed (2 stocks).

productive elements were produced in situ and that hormonic substances, if there be any, were not generally circulated or were neutralized. In the second series of experiments plants of unequal vigor showed no influence of the one of greater vigor or the one of lesser vigor, over the other. In the third and more elaborate series of grafts, neither the preponderance of female influence over male nor male over female affected in any noticeable degree, the sex expression of the elements of the graft.

In the light of some of the results obtained where stock and scion harbor physiological products of the other, and more startling, where the one affects hereditarily the offspring of the other, the negative results obtained in *Mercurialis annua* challenge subsequent investigations and in turn are challenged by them.

SUMMARY

1. Male and female grafts of unequal vigor show no influence of one upon the other.

2. Chain grafts consisting of three parts—male, female, male or female, male, female show no sex alteration.

3. Triple grafts—male, female, male or female, male, female yield negative results.

4. Chain grafts—male, female, male or female, male, female also yield negative results.

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Literature Cited

Avakian, A. A. & Jastreb, M. G. 1941. Hybridization by grafting. Iarovizatsia **I**: 50–77

————. 1942. Biol. Abs. (3552). 1942.

Dawson, R. F. 1942. Accumulation of nicotine in reciprocal grafts of tomato and tobacco. Am. Jour. Bot. **29**: 66–71.

Lysenko, T. O. 1946. Heredity and its variability. Translated by Theodosius Dobzhansky, New York.

Manoiloff. E. D. 1924. Weitere Erfahrungen über meine Blutreaktion zur Geschlechtsbestimmung bei Menschen, Tieren und durch Chlorophyll bei Pflanzen. München, Med. Wochenschrift **71**: 1784.

Satina, S. & Blakeslee, A. 1926. Biochemical differences between sexes in green plants. Proc. Nat. Acad. of Sci. **12**: 191–197.

Strasburger, E. Über Plasmaverbindungen pflanzlichen Zellen. Jahrb. wis. Bot. **36**: 493–610.

von Wettstein, F. & Pirschle, K. 1938. Über die Wirkung heteroplastischer Propfungen und die Übertragung eines Gen-bedingten Stoffes durch Propfung bei Petunia. Biol. Zentralblatt. **58**: 123–142.

Winkler, H. 1910. Über die Nachkommenschaft der Solanum Propfbastarde und die Chromosomenzahlen ihrer Keimzellen. Zeit. für Bot. **2**: 1–34.

Yampolsky, Cecil. 1930. Male-female grafts in *Mercurialis annua*. Jour. Heredity **21**: 65–72.

————. 1934. The cytology of the intersexual flowers of *Mercurialis annua*—a morphogenetic study. Am. Jour. Bot. **21**: 651–672.

————. 1930. Induced alteration of sex in the male plant of *Mercurialis annua*. Bull. Torrey Club **57**: 51–58.

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HISTOCHEMICAL STUDIES OF PHENOLASE AND POLYPHENOLASE IN THE DEVELOPMENT OF THE ENDODERMIS IN THE GENUS SMILAX

D. S. VAN FLEET

The purpose of this study was to determine the causal origin of the centripetal deposits of oxidized phenols that give rise to the Ø type endodermis and also to determine whether the variation in the endodermis through successive zones of range and environ is a functional response by adjustment or whether a given endodermal cell type is a fixed phenomenon within each species or clone. The study encompassed an interpretation of the origin and evolutionary significance, if any, of this tissue in its variations.

The endodermis of the subaerial stem of *Smilax* may be interpreted as a record of the environ of the plant, of the phenol content of the plant, of the action of phenolase in the oxidation and deposition of phenols (Van Fleet 1954a). Preliminary observations of the environmental types of endodermis and cortical cells exposed conspicuous differences between northern and southern species. High latitude and high altitude plants were found to have in the subaerial stem a mature endodermis with heavy centripetal walls containing deposited phenol derivatives. In low altitude and latitude plants the endodermis of the subaerial stems did not regularly have centripetal deposits of oxidized phenols.

In order to analyze endodermal variation it has been necessary to study, qualitatively and quantitatively, the constituents of the cortex and endodermis that are the causal histochemical agents in the product defined as the endodermis. In the higher vascular plants there are at least twenty types of endodermal cells depending on the chemical constituents that undergo differentiation changes at the cortical-stelar boundary (Van Fleet 1950, 1957). The type of endodermis in the study reported here is the long-recognized Ø type or centripetal type. This type of endodermis has been attributed to have phenol derivatives bound in radial and inner tangential walls of the cells and also free in the cell sap in early stages of development (Van Fleet 1954).

Methods. Field observations. Northern, southern and intermediate forms of all woody species of *Smilax*, except *S. californica*, were examined in the field and in the laboratory to determine kinds of endodermal variation in each species. Field collections were made throughout the extremes in range for each species. Sections were made either free-hand or with the freezing microtome of the below-ground internodes. In all cases the last internode in the region of the ground-line was avoided because the Ø type

endodermis is not differentiated regularly in this internode and does not develop at all above the ground-line (Van Fleet 1942). The irregular development of the Ø type endodermis in the internodes immediately in the region of the ground-line made it necessary to select the third internode below the ground-line as a starting place for the making of sections.

Collections of clones were made from the extremes of range for several species of *Smilax*, and these clones were transplanted to the opposite range extreme. Southern clonal forms were grown under northern conditions and northern forms were studied under southern or tropical greenhouse conditions. Variations were sought within the individual species in the new growth in clonal transplants. Previously developed characteristics in old stems were not lost, of course, but the differentiation of new characteristics in fresh stems was sought. The transposition in environ involved a change in latitude, altitude, forest to prairie or the reverse, and other similar changes. Clonal transplants were made of *S. hispida* var. *hispida*, *S. hispida* var. *montana*, *S. rotundifolia* (montana and austral forms), and for the extremes in range for *S. Bona-nox*, *laurifolia* and *S. lanceolata*.

Taxonomy. The conclusive and thorough studies by Coker (1944) of the woody species and varieties of *Smilax* were used for the naming and identification of the plants in this study. The views of Fernald (1944) on the naming of *Smilax hispida* were not adopted. The more precise interpretation of Clausen (1951) was followed in the naming and identification of *Smilax hispida* var. *hispida*.

The following species and varieties of *Smilax*, grouped according to approximate geographical range, were used. In many species there were *montana* forms, *austral* forms and glade or sun forms for comparative and colonal transplant studies. Innumerable forms were encountered that have not been taxonomically described and many polyphenol ecotypes were readily separated within each of the following species:

NORTHERN GROUP

S. hispida var. *hispida* Norton in Small (see Clausen, 1951).
S. hispida var. *montana* Coker (J. Elish. Mitch. Soc. 60: 49. 1944).
S. rotundifolia L.

INTERMEDIATE (PIEDMONT AND COASTAL PLAIN)

S. glauca Walter.
S. rotundifolia L.
S. hispida var. *hispida* Norton in Small.
S. Bona-nox L.

SOUTHERN OR SEMI-TROPICAL (SOUTHERN COASTAL PLAIN)

S. Bona-nox var. *littoralis* Coker (J. Elisha Mitchell Soc. 60: 42. 1944).
S. Walteri Pursh.
S. laurifolia L.
S. lanceolata L.
S. auriculata Walt.
S. havanensis Jacq.
S. pumila Walt.

Smilax californica was the only woody species in North America not included in the work. This species was omitted from the study because it is limited in range and belongs in the *hispida* group (Norton 1916, Coker 1944). The intensive work done on othe endodermis of the *hispida* group warranted this one deletion.

Several varieties of *Smilax herbacea* L. were used for comparison with woody species. Polyphenols in *S. herbacea* were found to remain unoxidized and this condition was also found to extend to other herbaceous species (*S. ecirrhata*, *S. lasioneuron*, etc.) but the latter were not extensively studied for polyphenol variation.

Polyphenol analysis. Early in the work it was observed that there is an interrelation between the quantity of phenolic glucosides in the cortex and the intensity of deposition of browning substances in the endodermis. When the quantity of phenols in the cortex was high a strongly developed endodermis was encountered. This became the basis for a working hypothesis; namely, that the quantity and quality of phenolic glucosides in the cortex are related to the extent of endodermal development.

Phenolic glucosides were found to be unhydrolized and unoxidized in the cortex. Cortical cells outside the endodermis did not show oxidation and deposition of phenols unless the tissue was wounded, killed or sectioned to bring about the "browning" reaction commonly associated with a disturbed metabolism.

The hydrolysis and oxidation of phenolic glucosides to quinoidal brown products appeared to be correlated remarkably with the endodermal quantitative development. Hence the goal in the methods used was to make correlative studies between the *functional browning* of the endodermis and the *adventitious browning* of the cortex induced in the tissue scrapings. The terms *functional* and *adventitious* have been applied to browning of phenol systems by Mason (1955).

Spectrophotometric qualitative and quantitative analyses were made from extracts taken from cortical scrapings and direct microspectrophotometer studies were made on fresh sections of cortical and endodermal cells. Determinations of the relative quantity of polyphenols, phloroglucitannoids and quinone derivatives were attempted. Qualitative tests for various polyphenols, phloroplucinol compounds and quinones were made and the tests found most reliable were used in analyses of tissue sections and of alcoholic extracts of tissue scrapings.

To obtain polyphenol browning products from the cortex 800 milligrams of internodal cortical scrapings, made to exclude the endodermis which can be seen easily with the naked eye, were ground in 5 grams of washed and ignited sand. The grinding and complete destruction of the cortical cells were carried out for two minutes in 5 ml. of water. Rapid enzymic browning of the phenols was allowed to take place in the ground material. At the

FIGS. 1–4. Transections of third internode. Arrows point to endodermis or endodermal cells lacking characteristic deposition. FIG. 1. *S. rotundifolia montana* form, arrow points to heavy endodermal deposition found in high altitude plants, ×30. FIG. 2. *S. rotundifolia montana* form transplanted to low altitude, arrow and dots indicate where endodermis should be anatomically visible but failed to differentiate, compare with figure 1, ×30. FIG. 3. Dry, sun form of *S. hispida*, arrows point to irregular and interrupted endodermis, ×30. FIG. 4. Prairie or glade form of *S. hispida* var. *hispida*, arrow points to endodermal layer that failed to differentiate as Ø type cell, brackets enclose outer sclerenchyma to show

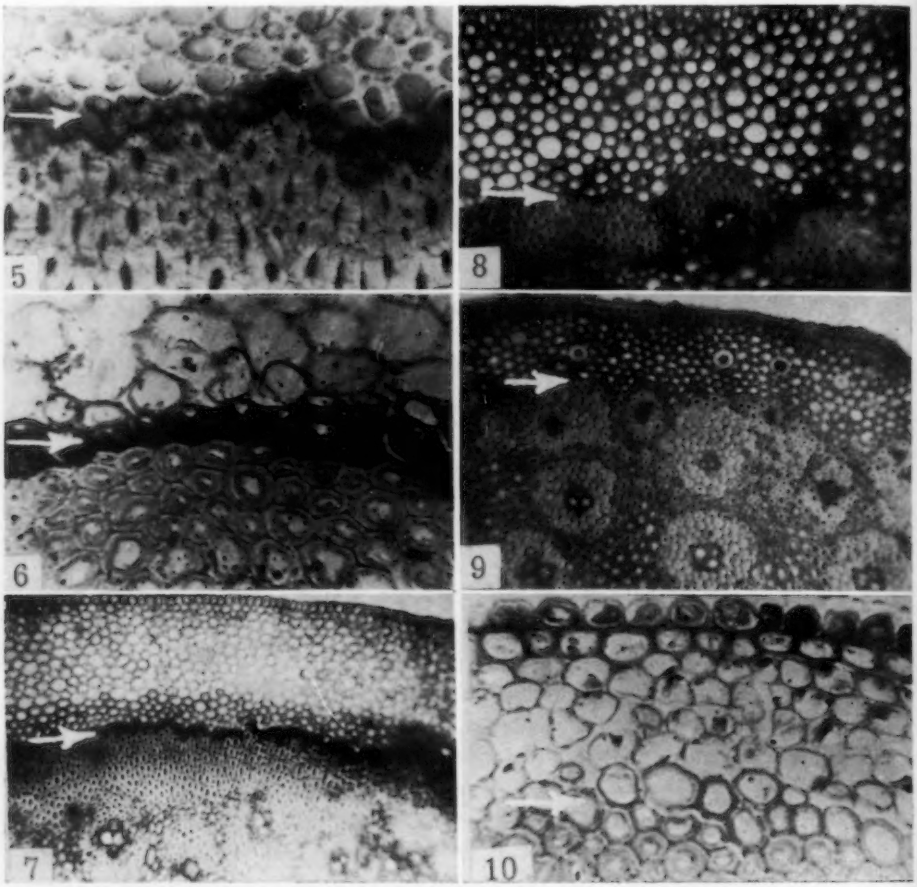
end of 10 minutes 10 ml. of ethanol were added and the brown oxidized quinoidal products were separated from cellular debris by filtering through a coarse grade of filter paper. Extracts made with hot alcohol also removed saponins and other substances which had to be precipitated and filtered out on cooling and gave results that were correlative but apparently no more significant than cold alcoholic solutions.

Results. Histological observations. Enododermal development in northern forms. A heavily developed endodermis was found to be typical of all high altitude forms found from 3800 to 4900 feet in the Smokies near Gatlinburg, Tennessee (fig. 1). Similar heavy deposition of oxidized polyphenols was found in forms of *Smilax rotundifolia* found in shaded, wet and north-slope locations. Transplanting these clonal types to sunny, dry low-altitude locations in Missouri resulted in the development of new cortical forms in which the polyphenol development in the cortex was reduced and polyphenol oxidation and deposition in the endodermis was weak (fig. 2).

The irregular and sporadic development of the endodermis, shown in figures 3 and 4, was typical of northern plants grown in full sun-light. Prairie and open-field forms of *Smilax hispida* var. *hispida* had an abundance of unoxidized phenols in the cortex. Failure of phenols to oxidize to quinones at the endodermal zone was found to be characteristic of plants which were robust and had a general appearance of vigor as compared with plants showing browning in the endodermis. When these plants were transplanted to wet and unfavorable locations they lost their appearance of strength and developed a heavy endodermis. Plants with a marked oxidation of phenols to phlobaphenes, growing in shade at high altitude, in wet locales and on north-slopes, had the solid endodermis as seen in figures 6 and 7. The rare *Smilax hispida* var. *montana* had a high amount of unoxidized phenols in the cortex and a heavy endodermis as shown in figure 7.

Endodermal development in southern forms. Phenol oxidation, condensation and localization in the endodermis were found only rarely in most southern forms of *Smilax*. An obvious Ø type endodermis was not found in subterranean stems of southern and tropical forms (figs. 8, 9, 10, 12 and 13). *Smilax auriculata* and *S. lanceolata* of the Gulf Coast and forms of the tropical *S. havanensis*[1] from Florida, Cuba and Puerto Rico were found to have a well-defined deposition in the endodermis of the root as in all species of *Smilax*, but the subaerial stem lacked the characteristic endodermal deposition and the cortical cells were low or lacking in phenolic glucosides. *S. Walteri* and *S. laurifolia* growing in sandy, wet locales and in brackish water along the Gulf Coast had an open aerenchymal cortex and did not have the Ø type endodermis (figs. 12 and 13).

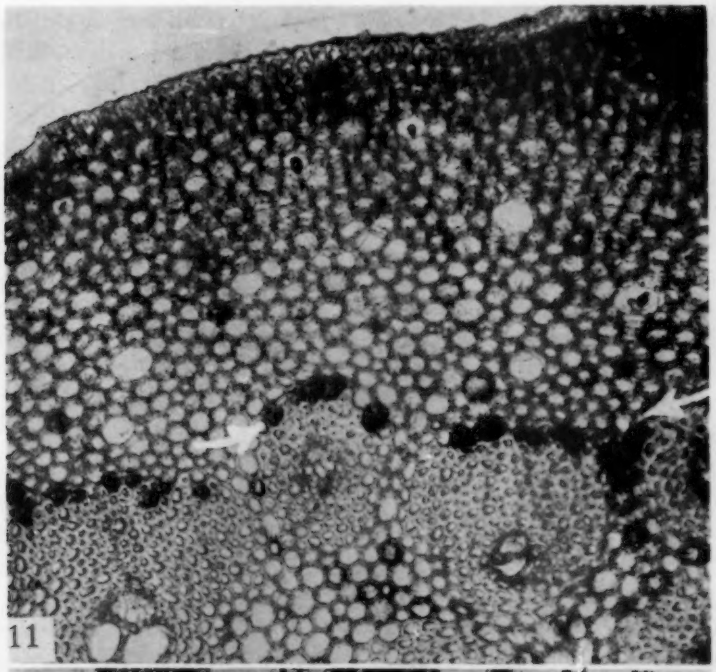
[1] The author is indebted to Dr. Jesus Velez Fortuno for samples of *S. havanensis* from Puerto Rico.



FIGS. 5–10. Transections of stem through the third internode below the ground-line. Arrows point to the endodermis. FIG. 5. *S. hispida* transplanted from a dry locale to a wet and shaded situation, compare with figure 6, ×76. FIG. 6. *S. hispida* from wet, shaded locale, ×76. FIG. 7. *S. hispida* var. *montana* showing the heavy deposition of phenols in the endodermis and innermost cortical cells, ×20. FIG. 8. *S. auriculata* a southern species lacking in endodermal deposition, ×40. FIG. 9. *S. havanensis* a tropical species lacking the Ø type endodermis, ×20. FIG. 10. *S. lanceolata* a southern species having a negligible deposition of oxidized phenols in the endodermis, ×48.

Endodermal development in intermediate forms. The deposition of phlobaphene phenolic substances was found to be irregular and diffuse in those forms which were intermediate in range between the extreme northern

FIGS. 11 and 12. Transections through the third internode below the ground-line, arrows point to the endodermis, ×90. FIG. 11. *S. glauca* growing in a dry location in full sun-light, having an interrupted and irregular differentiation of Ø type cells. FIG. 12. *S. Walteri*, a southern species, found in wet locations and brackish water, has aerenchymal cortex and absence of Ø type endodermis.



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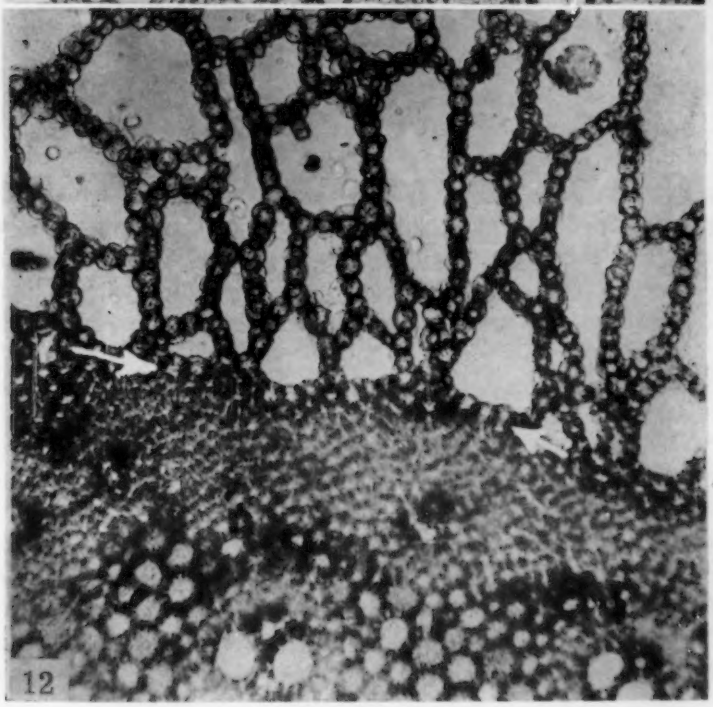

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and Southern types (figs. 14, 15, 16, 17 and 19). Full sun or prairie forms of *S. rotundifolia*, *S. hispida* and *S. Bona-nox* had a poorly defined endodermis (figs. 14, 15 and 16). The sun forms of *S. hispida* and *S. rotundifolia* were similar in endodermal development.

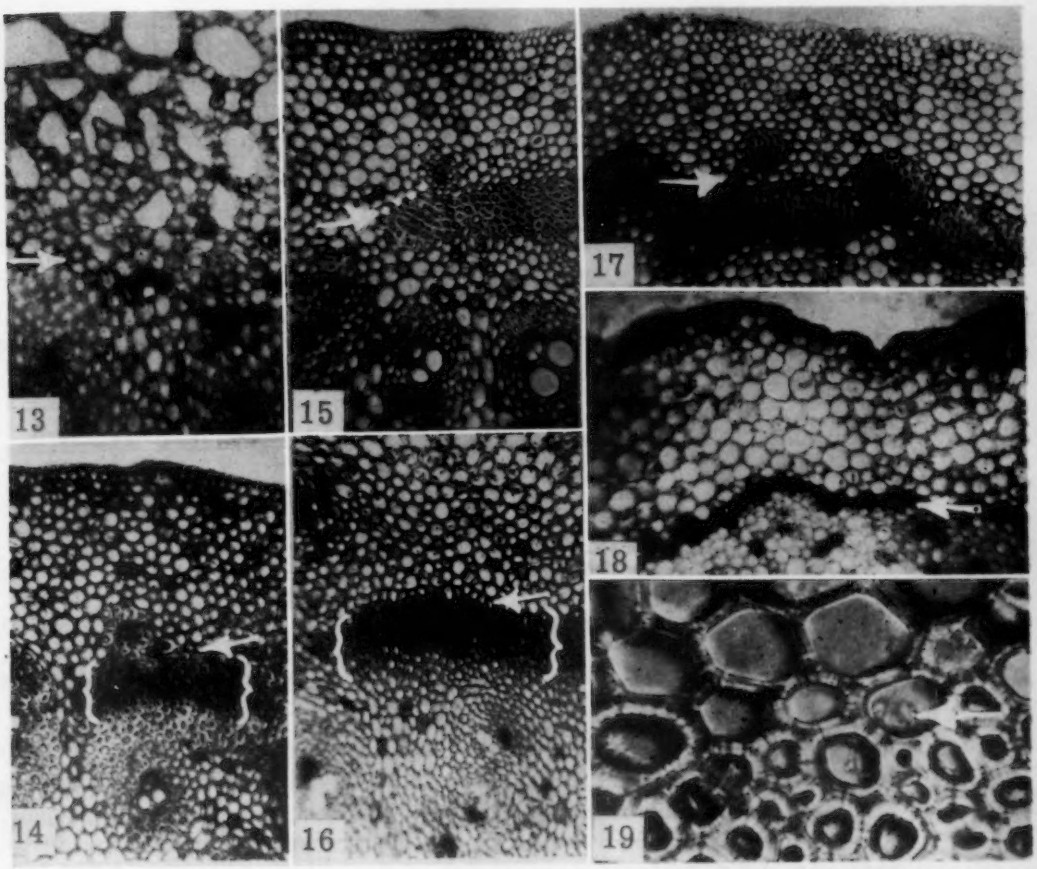
In hundreds of observations made in the last 15 years on *S. Bona-nox* a fully developed and clearly defined endodermis was never found. The endodermis was not of the centripetal Ø type in either sun and shade forms of *S. Bona-nox* and deposition in the endodermis in many clones was observed to be wanting and similar to the southern *S. auriculata* and *S. havanensis*.

Endodermal development in transplanted clones. *Smilax hispida* var *hispida* transplanted to the greenhouse developed a very weak endodermis and transplanting clones from shade and north-bluff locations to prairie sites resulted in an irregular or poorly developed endodermis. *S. hispida* transplanted from dry locations to wet and shaded spots developed a heavier endodermis (fig. 5). *S. rotundifolia montana* forms found in the Appalachians and Smokies and transplanted to prairie and open sunny locations in central Missouri produced lesser amounts of phenols in the cortex and a correspondingly irregular or negligible development of the Ø type of endodermis (figs. 1 and 2). *S. glauca* transplanted from shade to sunny locations continued to show the development of a pronounced Ø type endodermis but with gaps and irregularities in the number of cells having deposition (similar to condition shown in fig. 11).

Southern forms of *S. laurifolia* and *S. lanceolata* transplanted to northern locations did not develop the heavy centripetal endodermis found in northern species. *S. Bona-nox* when transplanted from sunny glade locations in southern Missouri to northern wet, shaded locations in northern Missouri developed a heavier deposition in outer sclerenchyma and the endodermis but the deposition of oxidized phenols did not approach that of the northern forms of *hispida, glauca,* and *rotundifolia*.

If southern species were derived from the northern *hispida*, or other northern species, we may deduce that the southern forms are not capable of adjustment reversion to the orignial type in endodermal response. If northern species evolved from southern, we may deduce that the northern species are capable of reversion to the original tropical type when transplanted. No conclusion from these deductions is possible, the origin of *Smilax* is not clear from the fossil record.

Irregularities in endodermal development. Forms of *S. hispida* were found that had a strongly developed endodermis in the southern part of the range for the species and northern forms were found that had a poorly defined endodermis; however, the southern forms having a heavily developed endodermis were found in shaded, north-slope, heavily wooded,



FIGS. 13–19. Transections through third internode below the ground-line, arrows point to endodermis. FIG. 13. *S. laurifolia* a southern species, aerenchymal cortex when found in wet locales, lacking Ø type deposit of phenols in endodermis, ×68. FIG. 14. *S. rotundifolia* growing in full sun and dry location, showing deposition of oxidized phenols in outer sclerenchyma as indicated by brackets, ×36. FIG. 15. *S. Bona-nox* from a sunny location on a dry bluff-side, lacking Ø type endodermis, ×36. FIG. 16. Typical condition of sclerenchymal deposition of oxidized phenols, shown by brackets, in a sun-form of *S. hispida*, ×36. FIG. 17. A prarie sun-form of *S. rotundifolia* having an irregular and slight deposition of oxidized phenols in the endodermis, ×36. FIG. 18. The southern species *S. pumila* having a strongly developed endodermis with a heavy deposition of oxidized phenols in the endodermis, ×36. FIG. 19. Absence of a detectible deposition of phenols in the endodermis of *S. Bona-nox*, typical of most sun-forms of this species, ×110.

dense bluff-side or other locations that could be categorized as northerly in aspect. The northern forms having a poorly defined endodermis were found in open glades, prairies, open fields and in high, well-drained habitats. In general the endodermis was found to be most pronounced in development in the northern forms and species. There were exceptional or provincial forms in isolated situations that were recording by polyphenol development

the variations of northern and southern aspect that occur within the range of any species.

There was one species that did not conform to the observed pattern and should be listed as an exception. *Smilax pumila*, having a limited range on the southern coastal plain and the edge of the southern piedmont, was found to have a strongly developed endodermis as shown in figure 18. It was anticipated that the endodermis would be negligible or absent in *S. pumila* grow in warm, sandy open pine woods. The well-developed Ø type endodermis found was perplexing in view of the southern range and south-

TABLE 1. *General summary of endodermal deposition in Smilax species graphically demonstrates the conspicuous difference between northern and southern forms, the exceptional southern S. pumila and the irregular intermediate types found in S. rotundifolia and S. Bona-nox.*

	Northern				Southern					
	hispida	*glauca*	*rotundifolia*	*Bona-nox*	*lanceolata*	*laurifolia*	*Walteri*	*auriculata*	*havanensis*	*pumila*
Complete Cylinder Endodermis	+	+	±	–	–	–	–	–	–	+
Interrupted Endodermis	+	+	+	+	–	–	–	–	–	–
Outer sclerenchyma Only	+	–	±	±	–	–	–	–	–	–

ern aspect in all habitats of the range. Coker (1944) said that "*Smilax pumila* is such an odd little plant that it easily could be the type species of a separate genus. It differs from all other members of the genus in the United States in several important respects----". While the writer does not propose that *S. pumila* may be the type species for a separate genus he would be happy to delete *S. pumila* from the genus at this time because it represents a striking exception to the general rule on endodermal development. A general summary can be made, as shown in Table 1, to emphasize the conspicuous

FIGS. 20–23. Transmittance wave-length curves in millimierons of oxidized cortical extracts, point readings taken at 10 mμ intervals with Spectronic 20 spectrophotometer (Bausch and Lomb Co.), samples held in selected ½" test tubes, all systems observed were light-or dark-brown the constituents showing quantitative variation from identical amounts of tissue, similar composition was indicated in all as shown but absolute identity was not confirmed. FIG. 20. Samples from *S. rotundifolia* showing a range from strong development of oxidized phenols in mid-continent shade forms (M) to weaker development in clones from prairie (P) and northern coastal plain (S). FIG. 21. Comparison of extremes in phenolic development in prairie (P) and woods (W) clones of *S. hispida* var. *hispida*. FIG. 22. Comparison of weak phenolic oxidation in the herbaceous (H) *S. herbacea* with the strong phenolic oxidation in the lignified (G) *S. glauca*. FIG. 23. Transmittance curves from clones of *S. glauca*, high transmittance of light-brown oxidized phenol solutions from clones in sand on the northern coastal plain (S), intermediate quantities of phenols from clones growing in sun locations in mid-continent (L), strong absorption of light by red-brown phenolic constituents from clones growing in shaded locations (C).

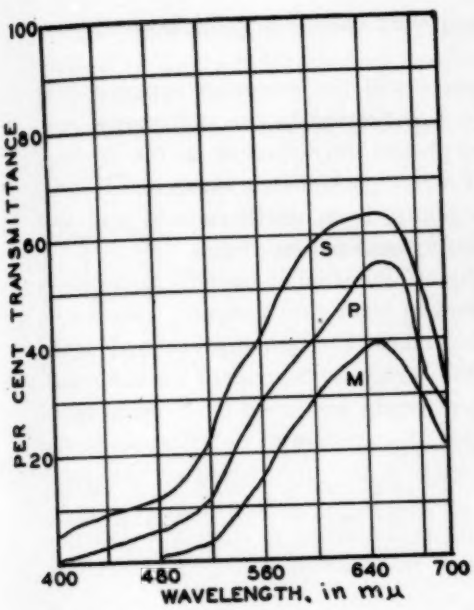


Fig. 20.

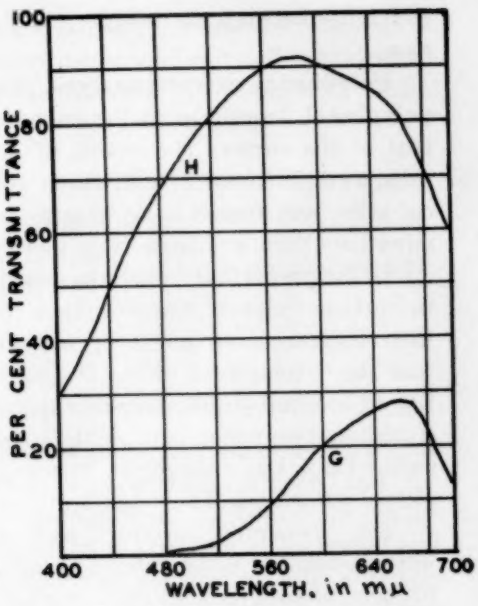


Fig. 22

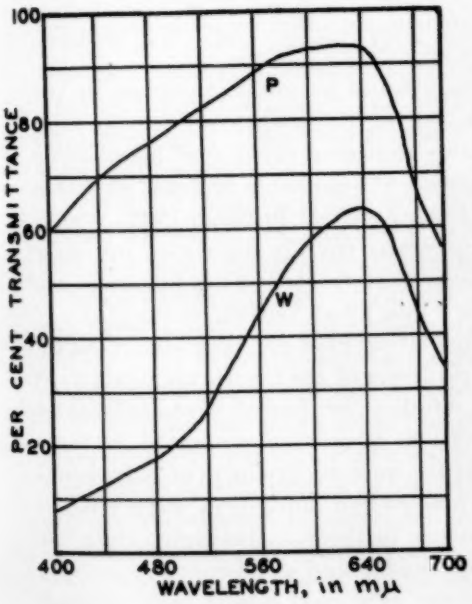


Fig. 21

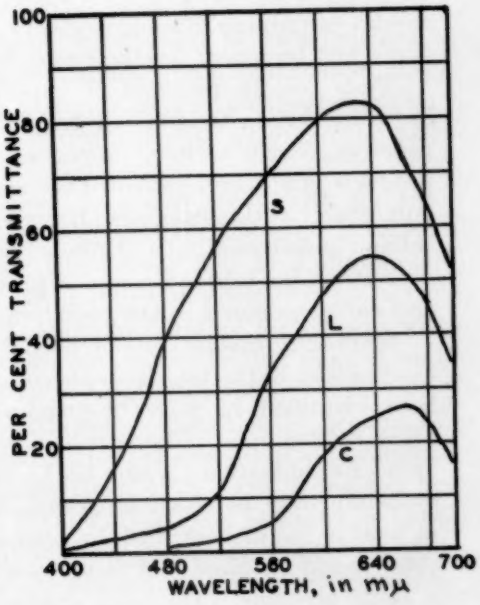


Fig. 23

difference between the northern and southern species in polyphenol deposition.

Polyphenol extract analysis. Results will be presented to show that polyphenol deposition in the endodermis is related to the polyphenol content of the cortex. The extent of polyphenol development in the cortical cells, as determined by extraction and direct photometric analysis of cortical cells, was found to be greater in plants from northern cold and wet situations than in plants from more sunny and genial climes.

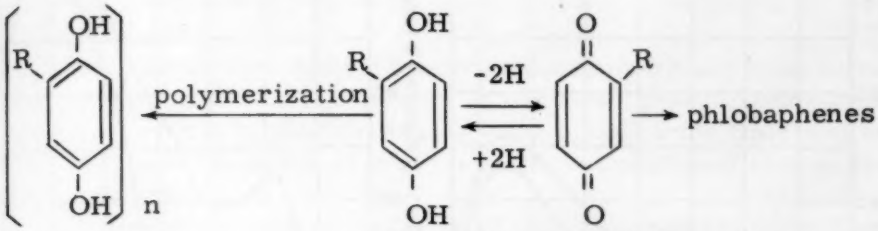
In the preliminary work the quantity of oxidation of phenols to quinones in cortical extracts was found to correlate with the presence, absence or intermediate development of an endodermis. The assumption was made that the development of the Ø type endodermis is dependent on the quantity of oxidizable polyphenols capable of being produced by a given type. Functional polyphenolase, as the catalyst of oxidation of polyphenols in the endodermis, was thought to be secondary to the production of the polyphenol substrates. These assumptions proved to be correct in part.

The "browning" products and quinones obtained in cortical extraction were assumed to be of different kinds and from different origins. Numerous phenols, phloroglucinols and catechols, were considered to be the source for the o-quinones and their oxidized browning products. Browning products in some types, as will be shown below, were apparently from phloretin glucosides containing the phloroglucin nucleus. In other types catechol quinones and browning products were found.

Tests for the presence of naphthoquinones or anthraquinones in the browning products obtained from the cortex or in the endodermis were negative. Nickel acetate, copper acetate, ammonia vapor and alkali color products in all cases indicated the presence of o-quinones and not naphthoquinones or anthraquinones (Brieger 1932, page 341 in Klein 1932). Cortical and endodermal cells of *Smilax* apparently contain diphenols and their derivatives the benzoquinones. A previous work treated of naphthoquinones and anthraquinones in the endodermis (Van Fleet 1954b).

Browning products of polyphenol oxidation have not been separated by biochemists. Extractable polyphenol precursors of the brown pigments have been identified in some biochemical studies by paper chromatography (Mason 1955)and phloroglucin derivatives have been separated in ferns by microsublimation (Widen 1944), but the quinone products of polyphenol oxidation have not been separated. These brown substances were studied in total in the present work by photometric methods. A multiple origin for these mixed oxidized and condensed quinoidal and phlobaphene products is quite probable. (The term phlobaphene here used means bark coloring or dyeing agents as in the direct derivation of the term. Stähelin and Hofstetter first used this designation in 1844, see Molisch, 1913).

The red, reddish-brown and black quinoid phlobaphene substances formed in the endodermis may be assumed to be oxidized and polymerized polyphenols. Paech (1950, 1953) has summarized the changes to which polyphenols are subjected as follows:



The red color product of the reaction of p-dimethylaminobenzaldehyde /HCL with phoroglucinol was obtained with cortical extracts and the vanillin/HCL test (Waage 1890) for phloroglucinol gave positive results with extracts of the cortex. Direct tests for phloroglucinol in free-hand and freezing microtome sections of young endodermal and cortical cells were also positive. Control sections, extracted with acid alcohol, were negative. When extracts were allowed to oxidize fully with polyphenolase and by autoxidation, the characteristic red color products with p-dimethylaminobenzaldehyde/HCL and vanillin/HCL could not be obtained. When polyphenols were incubated with macerated cortical cells containing polyphenolase, they were converted to quinoids and finally to deeply colored phlobaphenes that no longer gave the characteristic color reactions for phloroglucin and catechin precursors.

Tests for phloroglucinol and catechol were also made with p-nitrosodimethylanalin (see Brieger in Klein 1932) and for the color products obtained with diazobenzolsulfonic acid. Naphthanil Red R, a diazonium coupling agent, also gave bright red diazonium dye products with the cortical extracts and with phloroglucinol. Diazonium coupling for phenols was not used for proof for any one phenol because many related phenols and amines could be present in the tissue for diazonium coupling.

Phloroglucinol and catechol in *Smilax* were assumed to be present as glucosides. Glycyphyllin-rhamnoside and parillin or sarsaparilla glucosides, common to several species of *Smilax* (see Klein 1932), are hydrolized by glucosidase enzymes to phloretin. On further hydrolysis phloretin is split to phloroglucin and phloretic acid. Phloridzin as glucose + phloretin and glycyphyllin as rhamnose + phloretin are probably the primary glucoside precursors for the quinone and phlobaphene deposits found in *Smilax*.

Comparison of results on cortical extracts. A comparison of the transmission of light by quantitatively comparable cortical extracts gave the

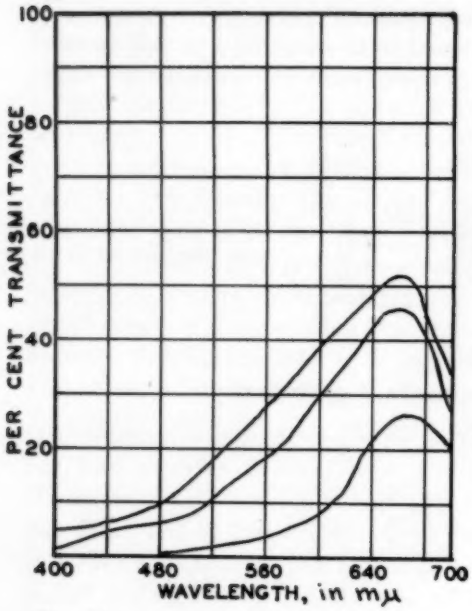


Fig. 24

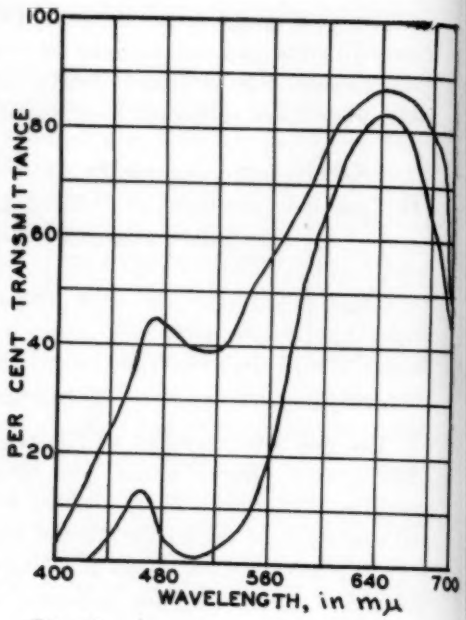


Fig. 26

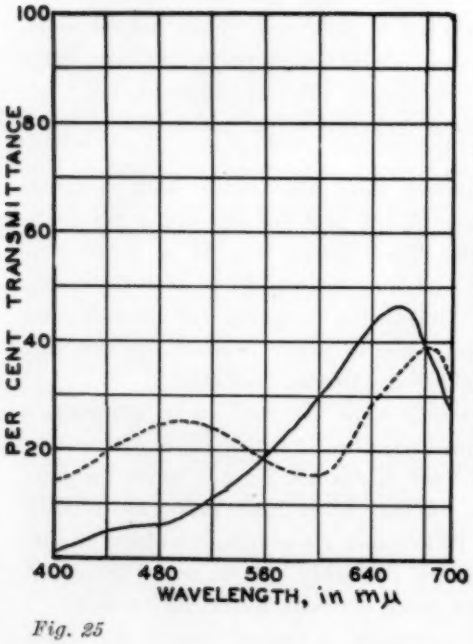


Fig. 25

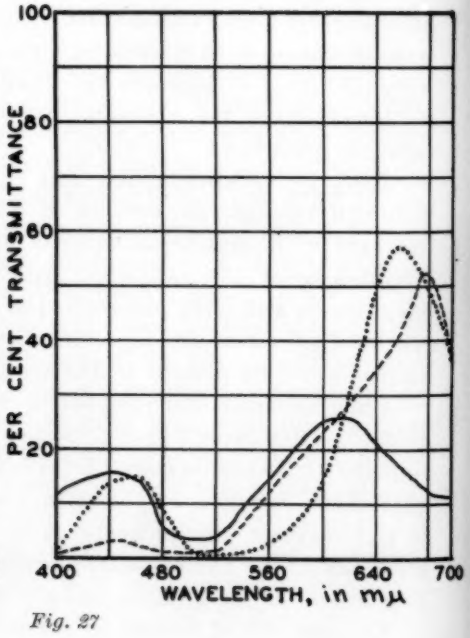


Fig. 27

anticipated results. In all cases the northern (*montana*) forms had a greater amount of extractible polyphenols than the southern or full-sun or prairie forms. The *montana* form of *S. rotundifolia* developed deep brown products in extracts and transmitted less light at 640 mμ than the extracts from clones growing in full sun on the northern coastal plain or in prairie or field habitats (fig. 20).

Similar results were obtained in a comparison of prairie and woods forms of *S. hispida* (fig. 21). The quantity of extractible phenolic material in austral forms of *S. hispida* var. *hispida* found in open fields, fence rows or shallow ditches was so low as to give negligible absorption of light in the visible spectrum.

The herbaceous forms of *Smilax* in all cases examined (14 clones from austral situations and 6 from an elevation of 6000 feet in the Smoky Mountains) had a high mount of phloroglucin throughout the cells of stele and cortex. However, the concentration of phloroglucinol and other precursors of browning products were relatively lower than in woody species as may be seen in a comparison with an extract from a typical northern form of *S. glauca* (see fig. 22).

Cortical extracts of clones of *Smilax glauca* found on the coastal plain as far north as New Jersey had a lower content of phenols than mid-continent clones growing in loam, clay or wet clay soil. The difference between northern and southern forms of *S. glauca* found on soil was not as great as the difference between clones found in sand and those from soil (see fig. 23).

FIGS. 24–27. Transmittance wavelength curves obtained as in preceeding figures 20–23. FIG. 24. Transmittance curves of the reaction of 2, 6-Dichloroquinonechloroimide with phenolic alcoholic solutions from *S. herbacea* (upper) and *S. hispida* (lower). The curve showing intermediate transmission (middle) is the characteristic curve obtained with phloroglucinol. The general similarity in curves suggests a common constituent system. FIG. 25. Transmittance curves of the reaction of 2, 6-Dichloroquinonechloroimide with phloroglucinol (solid line) and catechol (dotted line) in alcoholic solutions. The indophenol blue product with catechol in alcohol is a purple compound as is shown by the transmission curve. The red products obtained with phloroglucinol are red-brown in color like those obtained with phenol extracts as shown in figure 24. FIG. 26. The diaminomethylbenzaldehyde test for phloroglucinol gave color products with transmission characteristics as in upper curve. As in lower curve cortical phenol extracts from *S. Bona-nox* gave color products with diaminomethylbenzaldehyde similar to those obtained with phloroglucinol. FIG. 27. Curve shown in dotted line is the reaction product of phloroglucinol with diaminomethylbenzaldehyde. The curve shown with the dash line is the reaction product of the phenolic extract from *S. hispida* with diaminomethylbenzaldehyde. The curve in the solid line was obtained from the application of diaminomethylbenzaldehyde directly to cortical tissue and a direct microspectrophotometric analysis of the tissue, with point readings at 10 mμ intervals (general construction of microspectrophotometer see Van Fleet, 1954b). The aldehyde reaction product with phenols directly in the tissue was like that obtained with the extracted phenols in *S. hispida*, but *S. hispida* cannot be said to contain only phloroglucinol and a change in phloroglucinol or related phenols on extraction in alcohol is indicated in a comparison of these curves.

Phenols obtained from the cortex were compared photometrically with known phenols. The indigo blue test for phenols with 2,6-Dichloroquinonechloroimide gave an indophenol product with phloroglucinol that was quite different in color from that obtained with catechol and resorcinol (see fig. 25). Comparable spectral characteristics were obtained with phloroglucinol and the phenols from *S. herbacea* and *S. hispida* (fig. 24).

The diaminomethylbenzaldehyde test for phloroglucinol gave a stable and diagnostic color product. The characteristic reaction of diaminomethylbenzaldehyde with phloroglucinol is shown as the dotted line in the graph in figure 27. The light transmission curve for this phloroglucinol/aldehyde compound was also obtained when diaminomethylbenzaldehyde was applied to extracts from *S. Bona-nox* and *S. glauca* (see figure 26). Direct observation of this phloroglucinol/aldehyde reaction in fresh sections of *Smilax hispida* gave the same general transmission curve, with the microspectrophotometer, as in the extracts from *Smilax hispida* (fig. 27).

Diazonium coupling reactions for various phenols with naphthanil diazo red RC and other diazo salts gave dye products confirming the presence of phloroglucinol compounds. The general conclusion may be offered that phoroguecinol or phloroguecinol derivatives are the precursors to the browning products *functionally* developed in the endodermis and *adventively* induced in making cortical extracts. The quantity of phenolic material in the cortex was correlated, as shown by transmission at 640 mμ, with the endodermal development.

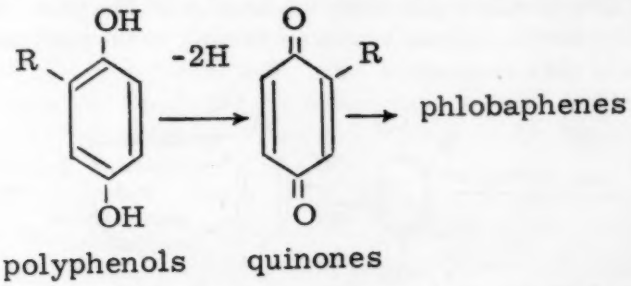
Discussion. The endodermis is the locus for the oxidation of diphenols to the corresponding quinones. Oxidation of hydroxynaphthols and hydroxyanthrols to the corresponding quinones also takes place in the endodermis (Van Fleet 1954b). Regardless of the type of phenol, naphthol or anthrol developed, the oxidation to quinones and the deposition of phlobaphenes take place in the endodermis of some plants but not in all. In southern woody species, and in herbaceous species, the quinone oxidation system is not fully developed and the endodermis is not visibly differentiated to the Ø type. Failure of quinone oxidation may be either a result of inhibition of β-glucosidase and polyphenolase or a result of blocking of phenol oxidation by antioxidants in the cortex. The oxidation-reduction potential (E'o) of the cortex may be too negative for oxidation of phenols to quinones, i.e. poising the potential of cortex and endodermis below the point for oxidation of phenols to quinones (Van Fleet 1954a).

There are unoxidized polyphenols inside young cortical and endodermal cells but endodermal cell walls contain oxidized quinoidal browning products. These quinoidal wall materials in the Ø type cell are a result of polyphenolase action and a result of a rise in oxidation-reduction potential in the wall to allow autoxidation. The phlobaphenes bound to the crystalline

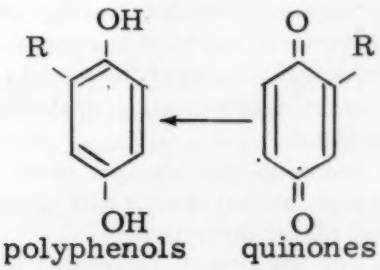
cellulose micelles are of quinoidal origin, but the entire mechanism of deposition has not been clarified.

It is highly probable that unmethylated lignins may be the source for some of the *functional* browning of endodermal walls (Mason, page 150, 1955 on sources of browning phenolic substances). Failure of both lignification and the browning reaction occurs in herbaceous species of *Smilax*. The compound failure of lignification and functional browning in these herbaceous plants is intriguing but probably is not a causal correlation in the origin of the herbaceous condition and the loss of the Ø type endodermis in these plants. Lignified species have a broad range of functional browning but there are lignified plants lacking any visible sign of browning deposition.

The deposition of oxidized phenols in the below-ground stem proceeds irreversibly *in the dark* to phlobaphenes that accumulate in the walls.



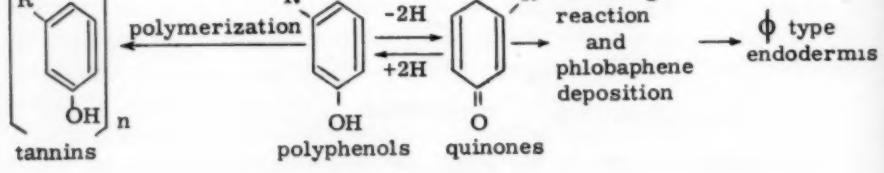
In above-ground tissue in *the light* the reaction proceeds in a reducing direction with accumulation of polyphenols in the unoxidized form in cortical and endodermal cells.



The deposition of browning products in the endodermal walls is related to the quantity of polyphenol acumulation in the cortex. Northern forms contain greater amounts of phenolic substances, as demonstrated in the photometric studies, and may be readily observed to have the heaviest deposition of phlobaphenes in the walls of the endodermis. In general, unfavorable situations (shade, shorter growing season, wet and cold north

facing bluff-sides, etc.) favor the formation, hydrolysis, oxidation and deposition of polyphenols.

The chemical and physical barrier presented by the endodermis as a result of functional browning, in plants in the north, would appear to have evolutionary significance. An exact gradation in endodermal development through successive zones of range is not clearly defined in all species but it is apparent that endodermal deposition is related to physical environmental factors. A change in the cortex and endodermis takes place when clones are transplanted, but the greater part of the histochemical pattern is an inheritance from the past, and the apparently new cortical and endodermal forms that become established are not innovations they are merely alternatives. We must conclude that the differentiation of the polyphenol Ø type endodermis is a result of reversible endogenous causal factors influenced in the direction of reaction by environmental locale. The more northerly or generally unfavorable the location of the plant the greater is the tendency for the reaction to run irreversibly to the right and to the development of the endodermis.



SUMMARY

1. The purpose of the study was (a) to determine the causal origin of the centripetal deposits of oxidized phenols in the Ø type endodermis, (b) to determine whether apparent variations in the endodermis through zones of species range and environ are a result of functional response by adjustment, (c) to determine whether a given endodermal cell type is a fixed phenomenon within each clone.

2. High latitude and high altitude (northern) plants were found to have, in the subaerial stem, an endodermis with centripetal walls containing oxidized and deposited phenol derivatives.

3. In low latitude and low altitude (southern) plants the endodermis of subaerial stems did not regularly contain deposits of oxidized phenols.

4. The deposition of oxidized phenols was found to be irregular and diffuse in plants intermediate in range.

5. Clonal transplants showed response to new habitat by development of a more pronounced endodermis in northern situations but in general an irregular or weak endodermis developed in southern and tropical forms

grown under northern conditions. Northern forms grown under southern or tropical conditions did not develop an endodermis of the conspicuous Ø type.

6. Spectrophotometric analyses of cortical extracts, and direct microspectrophotometric analyses of the phenolic content of the cortical cells in fresh sections, showed that the quantity of polyphenols was in general greater in northern than in southern, prairie or full-sun forms. The mountain and shade forms of several species developed browning reaction products in cortical extracts; these browning products transmitted less light at 640 mμ than similar extracts from clones grown in full sun in northern coastal plain, prairie or field habitats.

7. Phenols obtained from the cortex were compared photometrically with known phenols. Transmission of the indophenol color products of the reaction of 2,6-Dichloroquinonechloroimide with phenol extracts from th cortex were compared with the indophenols obtained with phloroglucinol. Phloroglucinol was found to be the probable phenolic substance present in cortical cells and endodermal cells prior to the browning reaction. The diaminomethylbenzaldehyde test for phloroglucinol gave a stable and diagnostic color product in fresh sections and extracts confirming the presence of phloroglucinol.

8. It may be concluded that phloroglucinol and possibly other polyphenols are the precursors to the browning products *functionally* developed in the Ø type endodermis and *adventitiously* induced in the cortex by wounding and making cortical extracts. Northern forms of *Smilax* produce large amounts of oxidizable phloroglucinol derivatives in subaerial stems and the endodermis is prominently developed up to the groundline. Southern forms develop smaller amounts of phloroglucinol derivates in subaerial stems, even when grown under northern conditions, and the Ø type endodermis is absent or irregularly developed.

9. It is apparent that phenolic oxidation and deposition to form the Ø type endodermis in subaerial stems is a response to environ limited primarily to northern or intermediate species. Supportive evidence for the causal mechanism (tannin ← polyphenol ⇄ quinone → phlobaphenes → Ø type endodermis) has been adduced but the evolutionary significance has not been revealed.

Department of Botany, University of Missouri,
Columbia, Missouri

Literature Cited

Brieger, R. 1932. Phenole und Chinone. (In Klein, G. 1932. Handbuch der Pflanzenanalyse Vol. II. Verlag von Springer. Wien).

Clausen, Robert T. 1951. *Smilax hispida* versus *S. tamnoides*. Rhodora **53**: 109–111.

Coker, W. C. 1944. The woody Smilaxes of the United States. Jour. Elisha Mitchell Sci. Soc. **60**: 27–69.

Fernald, M. L. 1950. Gray's Manual of Botany. 8th ed.

Klein, G. 1932. Handbuch der Pflanzenanalyse. Zweiter Band. Verlag von Springer. Wien.

Mason, H. S. 1955. Comparative biochemistry of the phenolase complex. Advances in Enzymology. **16**: 105–184.

Molisch, Hans. 1913. Mikrochemie der Pflanze. Jena.

Norton, J. B. 1916. The eastern and the western migrations of *Smilax* into North America. Jour. Washington Acad. Sci. **6**: 281–283.

Paech, K. 1950. Biochemie und Physiologie sekundärer Pflanzenstoffe. Berlin-Göttingen-Heidelberg.

————. 1953. Über die Lichtkeimung von *Lythrum salicaria*. Planta **41**: 525–566.

Van Fleet, D. S. 1942. The development and distribution of the endodermis and an associated oxidase system in monocotyledonous plants. Am. Jour. Bot. **29**: 1–15.

————. 1950. The cell forms, and their common substance reactions, in the parenchyma-vascular boundary. Bull. Torrey Club. **77**: 340–353.

————. 1954a. Chap. VI. Cell and tissue differentiation in relation to growth in plants. Dynamics of Growth. edited by Boell. Princeton.

————. 1954b. The significance of the histochemical localization of quinones in the differentiation of plant tissues. Phytomorphology **4**: 300–310.

————. Histochemistry, evolution and function of the endodermis. Botanical Review (in press).

Waage, Th. 1890. Über das Vorkommen und die rolle des Phloroglucins in der Pflanze. Ber. d. d. Bot. Ges. **8**: 250–292.

Widen, B. 1944. Untersuchungen über die Phlorogluzinderivate Finnischer Farnarten. Acta Botanica Fennica No. 37 (1–79).

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A GLASS SUPPORT FOR PLANT TISSUE PIECES CULTURED IN LIQUID MEDIUM[1]

CLARENCE T. LANGE AND PAUL R. DESJARDINS[2]

As Gautheret (1950) has pointed out, there is a somewhat pronounced inhibition of callus proliferation on plant tissues in contact with a liquid medium. Because of this, complete and prolonged immersion of most tissues

FIG. 1. Flasks, left to right, flask without medium and foil cover, flask after sterilization, and flask with stem segment in culture. Shown in the foreground are the foil wrap, a slotted Pyrex tube and cork borer used in cutting foil wrap.

[1] The above reported work was supported in part by Cancer Research Funds of the University of California.

[2] The authors take this opportunity to thank Dr. J. M. Wallace for his comments on the work and on the preparation of the manuscript.

is seldom desired. To allow either partial immersion or periodic bathing some means of tissue support must therefore be devised. This paper describes such a support.

During the course of work involving the preparation of tissue cultures from woody stem segments a useful culture flask was devised. This flask (fig. 1), while similar in appearance, differs materially from the type used for growing algae as described by McVeigh and Brown (1954).

The two main components of the culture flask are a 250 ml. wide mouth Erlenmeyer flask and an 18 × 150 mm. Pyrex test tube. The test tube, which actually supports the tissue, is suspended within the flask by a tight fitting cotton plug prepared in the form of a collar. Several slots are made in the bottom two centimeters of the test tube by means of a glass cutting machine[3] equipped with a cutting wheel 2 mm. in thickness. The cotton plug in the flask is covered with an aluminum foil wrap to prevent its ignition when flaming the mouth of the test tube. The foil is placed on the flask subsequent to introduction of the liquid medium but prior to sterilizaion.

This type of culture flask has been found to have several advantageous features. Firstly, the tissue segments are introduced by dropping them into the test tube, thus eliminating the necessity of their specific placement in some anchoring medium or other type holder. Secondly, because of the small opening of the test tube and because it alone is opened subsequent to sterilization, there is less danger of contaminating the culture medium in the large flask. Finally, the height of the test tube can be adjusted so that the tissue is partially immersed in the liquid medium, or to a position which provides a bathing of the tissue by the medium when the flask is placed on a shaking machine.

DEPARTMENT OF PLANT PATHOLOGY, CITRUS EXPERIMENT STATION
UNIVERSITY OF CALIFORNIA
RIVERSIDE, CALIFORNIA

Literature Cited

Gautheret, R. J. 1950. Action du contact d'un milieu aqueux sur la morphogénèse des cultures de tissu cambial de *Salix caprea*. C. R. Soc. Biol. **144**: 626–629.

McVeigh, Ilda & Brown, W. H. 1954. In vitro growth of *Chlamydomonas chlamydogama* Bold, and *Haematoccocus pluvialis* Flotow Em. Wille in mixed cultures. Bull. Torrey Club **81**: 218–233.

[3] The glass cutting machine used is manufactured by the Carl Pistorius Machine Co. and is marketed by the Scientific Glass Apparatus Co., Inc., Bloomfield, New Jersey.

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TWO GENERA OF MOLDS WITH LOW TEMPERATURE GROWTH REQUIREMENTS

C. W. HESSELTINE AND PATRICIA ANDERSON

Recently we have studied and monographed (1956) the genus *Thamnidium* in the Family Thamnidiaceae. The genera at present recognized in this family, in addition to *Thamnidium*, are *Chaetostylum*, *Chaetocladium*, *Helicostylum*, and *Cokeromyces*. The genera *Chaetostylum* and *Chaetocladium* which are the subject of this paper, are so interrelated with *Thamnidium* that they were the next logical group of fungi to study in the Mucorales. This is particularly true for we had adequate taxonomic material of all of the known species and varieties of both genera as well as the zygosporic stage of one of the species of *Chaetocladium*.

Most reports of the isolation of *Chaetostylum* and *Thamnidium* concern their isolation from meat and meat products stored under low temperatures. A discussion of the occurrence of *Chaetostylum* must also be one of *Thamnidium* since the two genera are often considered under the name *Thamnidium*. According to Jensen (1954), these genera are regular members of the flora found on aging and tenderizing beef held in coolers. They are among the molds which grow on the cut surfaces of meat, and their mycelia bring about the so-called "whiskery beef." Their actual role in tenderizing beef is still in doubt. The principal species appear to be *Chaetostylum fresenii* (syn. *Thamnidium chaetocladioides*) and *T. elegans*. Brooks and Hansford (1923) reported the occurrence of these species on meat imported from the southern hemisphere, and Brooks and Kidd (1921) reported *Thamnidium* sp. from Argentina and New Zealand. Haines and Smith (1933), who studied meat in small refrigerators, stated that *Thamnidium chaetocladioides* (*Chaetostylum fresenii*) was the most common mold present. Semeniuk and Bell (1937) reported that this species and *T. elegans* occurred in cold storage lockers in Iowa. Empey and Scott (1939) found *Thamnidium* on cold-stored meat in Australia, and Bidault (1921) observed both *Chaetostylum fresenii* and *T. elegans* on frozen meat in France. Gisshe (1937) found both forms as spores in the air of a refrigerator used to store eggs. Moran, Smith and Tompkins (1932) and Tompkins (1933) studied how carbon dioxide inhibits these two fungi growing on meat. As much as 20% carbon dioxide was necessary to essentially inhibit *C. fresenii*. Wolf and Wolf (1950), studied over thirty chemicals for the control of molds on meat and used as one of their test organisms *C. fresenii* (*T. chaetoceadioides*), which was isolated from meat. Christiakoff and Bacharova (1938) studied both *T. elegans* and *C. fresenii* with

regard to their growth on foodstuffs (particularly meat) at temperatures of 0° C or below. *C. fresenii* was reported to grow more rapidly on fresh beef than on nutrient agar. Doubtless *Chaetostylum* has been reported elsewhere as *Thamnidium* species, but it is not the object of this paper to review all these reports.

Chaetostylum van Tieghem et Le Monnier,

Ann. Sci. Nat., ser. V. *17:* 328. 1873.

1870. *Bulbothamnidium* Klein, Verh.

Zool.-Bot. Ges. Wien *20:* 557. (*Nomen provisiorum*).

Mycelium richly branched in and on the substrate, without rhizoids or stolons; sporangiophores erect, branched and sometimes with more than one sporangium per sporangiophore, typically ending in a large terminal sporangium; branches below the large sporangia bearing sporangiola; branches bearing sporangiola arising singly or in a whorl from a swollen portion of the sporangiophore, primary branches in one or more false or true whorls; the ultimate whorl with short straight stalks ending in sporangiola, the central axis bearing this whorl larger and forming a stiff sterile spine; sporangia large, globose, many-spored, with incrusted wall and a columella; sporangiola globose, few-spored, with a persistent wall, freed as a whole, lacking columellae; sporangiospores alike, oval, hyaline, smooth-walled; zygospores unknown; growth at low temperatures.

This genus is closely related to *Thamnidium*, *Helicostylum* and *Chaetocladium*, and especially so to the latter two genera. It is distinguished from *Helicostylum* by the sporangiola which are borne upon straight rather than curved ultimate branches of the sporangiophores. With but two exceptions, *Helicostylum elegans* and *H. nigricans*, *Helicostylum* has pyriform sporangiola while *Chaetostylum* always has globose sporangiola. *Chaetostylum* can be distinguished from the genus *Thamnidium* in that it produces sterile spines at the ends of certain branches, while *Thamnidium* usually has no sterile spines and never has spines on its smaller branches. It differs from *Chaetocladium* in that it produces a terminal sporangium, and each of the sporangiola typically contains several sporangiospores. *Chaetocladium* produces both stolons and rhizoids, while *Chaetostylum* does not.

Although Klein used the name *Bulbothamnidium* three years before van Tieghem and Le Monnier erected the genus *Chaetostylum*, it cannot be used, for Klein himself was not clear whether it represented a distinct genus or whether it was but a sporangiolar part of *Mucor mucedo*. The latter seems to have been his more favored view. Since Article 43 of the International Code of Botanical Nomenclature states that a name is not valid if the author does not consider his name seriously, it appears that this name should be treated as a *nomen provisiorum* and that *Chaetostylum*, which is the name commonly used by monographers of this genus, should be the correct one. This was pointed out by van Tieghem and Le Monnier when they erected the genus

Chaetostylum three years after Klein's proposal. However, there is no question as to the identity of the fungus that Klein studied since he gave a description of it and had several illustrations to show what he was studying. Schroeter (1897) reduced the genus *Chaetostylum* to a subgenus under *Thamnidium*.

Chaetostylum fresenii van Tieghem et Le Monnier

Ann. Sci. Nat., ser. V. *17:* 329. Pl. XXIII, figs. 61–63. 1873.
1851. *Ascophora pulchra* Preuss, Linnaea, *24:* 139. (Fide Fischer 1892)
1870. *Bulbothamnidium elegans* Klein, Verh. Zool.-Bot. Ges. Wien. *20:* 557.
1881. *Thamnidium chaetocladioides* Brefeld, Bot. Unters. u. Schimmelpilze *4:* 58.
1886. *Thamnidium fresenii* (van Tieghem et Le Monnier) Schroeter, In Cohn's Kryptogamen-Flora v. Schlesien *3* (2): 210.
1889. *Chaetostylum echinatum* Sorokine, Rev. Mycol. *11:* 141.
1910. *Bulbothamnidium pulchrum* (Preuss) Sumstine, Mycologia *2:* 143.
1910. *Bulbothamnidium pulchrum* var. *variabile* Sumstine, Mycologia *2:* 144.
1933. *Chaetostylum fresenii* var. *macrosporum*. Naumov, Mat. Myc. et Phytopath. (Reference not seen, but taken from Naumov, Clés des Mucorinées, p. 60 and XXXI. 1939).

Colonies on synthetic mucor agar (SMA) at 7° C at 19 days of age pale olive gray, pale smoke gray to smoke gray (Ridg., 1912), reaching lid of Petri dish, rapidly to somewhat restrictedly growing; colony reverse white with uneven margin and sometimes slightly wavy zonate upon potato dextrose agar (PDA); odor sweet and pleasant, somewhat like apples; sterile aerial mycelium sometimes present; sporangiophores hyaline, arising directly from substrate mycelium, typically smooth-walled or faintly striate, ending in a large sporangium or with a sterile spine in shorter sporangiophores, sometimes with more than one sporangium per sporangiophore, no septations below the sporangium, 15–25 μ in diam., sometimes up to 52 μ; stolons and rhizoids absent; branches bearing sporangiola and sterile spines arising singly from swelling of sporangiophores or as a whorl of branches about the sporangiophore, typically large numbers (at least 20), arising from one place, never circinate, these primary branches may end directly in sporangiola (up to 50 μ in length) or in successive whorls of branches which in turn produce sporangiola on short stalks, branches to at least 200 μ in length and up to 8 μ in diam. sometimes minutely roughened; region of branches from which the whorls arise always swollen, up to 22 μ; sterile spines hyaline, 5–8 μ in diam. tapering to 2–4 μ in diam. and to 140 μ in length; stalks of secondary branches bearing sporangioles 8–15 μ long and about 2 μ in diam.; sporangia always formed before sporangiola, pale yellow to olive gray in reflected light, dark gray in transmitted light, deliquescent, globose, sporangial wall incrusted, 80–225 μ in diam.; columellae pyriform, ovoid or even globose in the smaller ones, sporangiophore often constricted below the sporangium, hyaline to light brown, smooth, collar poorly defined, 35–120 × 30–110 μ, a few to only 20 μ in diam. (fig. 1); sporangiola breaking off with part of stalk, hence showing a point of fracture below the sporangiolar wall, 8–28 μ in diam., containing from one to 20 or more sporangiospores, bluish gray, often with globose or dorsiventrally flattened columellae up to 10 μ

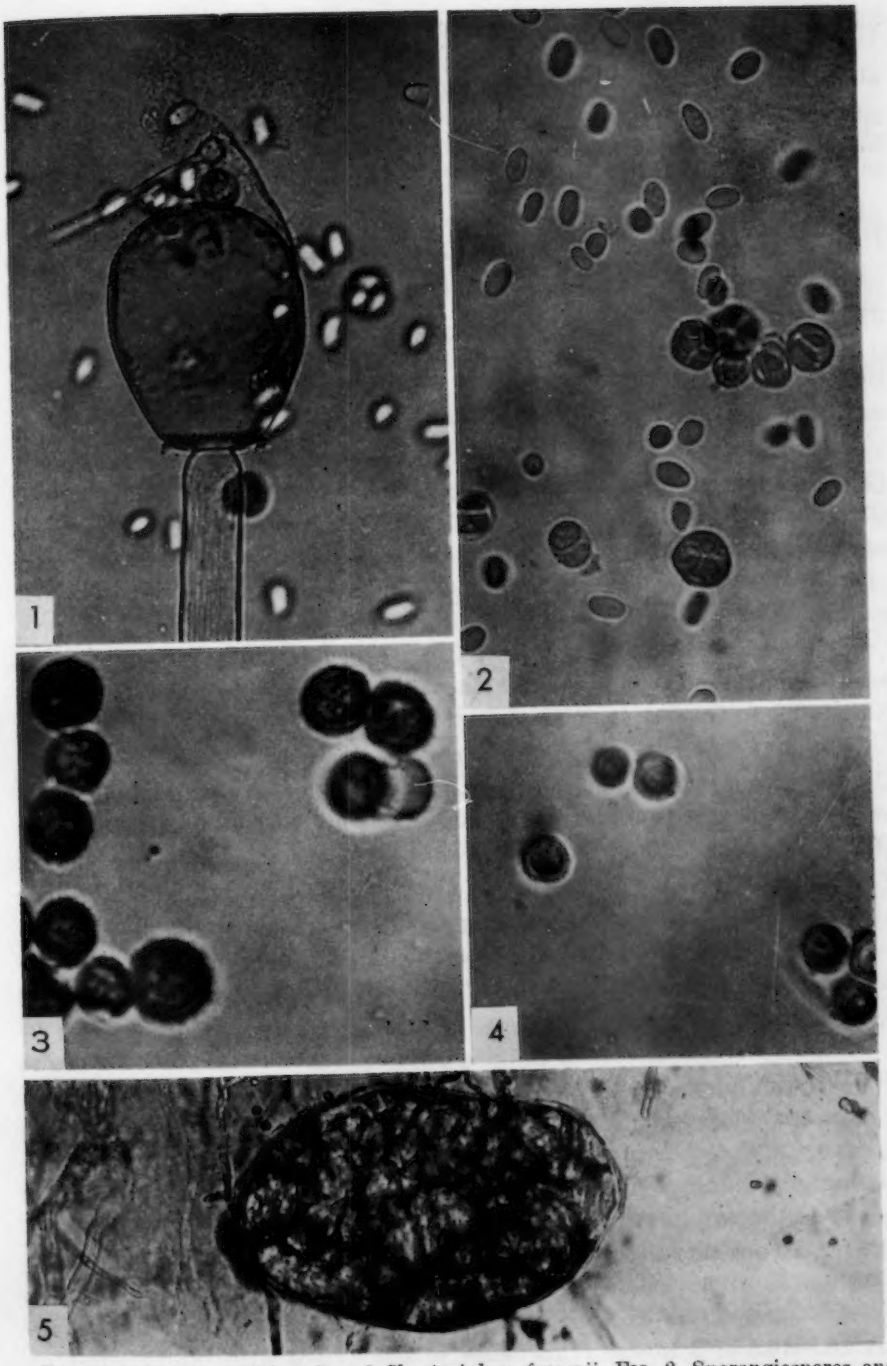
in diam. (fig. 2); sporangiolar wall persistent, breaking, minutely roughened; sporangiospores oval to elliptical, often somewhat irregular in shape, smooth-walled, uncolored, equal in size from sporangia and sporangiola, 7.5–15 × 5.5–8.5 μ, atypical spores up to 8.5 × 25.5 μ; zygospores never reported; chlamydospores missing; few oidia seen in substrate mycelium and these single or in chains, oval in shape, and up to 20 × 26 μ; substrate mycelium very irregular in shape and diameter, filled with granular material when young.

There is but one species in the genus *Chaetostylum;* this species is represented by two typical isolates in the NRRL Culture Collection. These isolates are the basis of our study. Strain NRRL 686 was received from the Centraalbureau voor Schimmelcultures, Baarn, Holland, which had received it from Solberg. The second culture, NRRL 2305, was isolated by the senior author from spoiled beef cracklings obtained from Mr. W. J. Poplack, Detroit, Michigan.

Upon Czapek agar under the same conditions as those above, growth is thin but normal sporangiophores with one or more sporangia, and sporangiola are produced. The organism grown on PDA showed heavy growth and the Petri dishes were entirely filled with mycelium. Strain NRRL 2305 on SMA differs markedly in gross appearance from NRRL 686 in that the colonies are restricted though they grew to the lid of the Petri dish. Sporangial colonies are formed by NRRL 2305. Our cultures grow equally well at 7° and 20° C but abnormal growth results at higher temperatures.

This species was studied on synthetic *Mucor* agar (SMA), potato dextrose agar (PDA), Czapek's solution agar and malt extract agar prepared by the procedures described elsewhere by us (1955). One of the remarkable things about the above strains is the uniformity of growth and appearance upon favorable nutrient media.

When our two strains of *Chaetostylum fresenii* were mated upon PDA, Emerson's agar and yeast extract agar at 7° C the colonies were identical in appearance. The colonies grew together, filled the Petri dishes, and covered the surface of the agar. No zygospores were observed either near the lid of the dish or at the surface of the agar. When these same combinations were made upon the above media and incubated at 25° C colonies were low in height, hardly in contact with each other, and sporulation was abnormal. Needless to say no zygospores were formed. Additional studies at 20° C and 7° C using such media as steep agar, yeast extract agar, malt extract agar, YpSs medium (1954) and Barnett and Lilly's agar (1950) gave negative results. It is believed by the authors that with additional strains zygospores could be produced. Especially interesting was the growth of these cultures on yeast extract and malt extract agars. Unlike their growth on the other media, the colonies failed to cover the surface of the agar at 7° C but did fruit against the lid of the Petri dish. At 20° C at 19 days of age on the



FIGS. 1–5. FIG. 1. Columella of *Chaetostylum fresenii*. FIG. 2. Sporangiospores and sporangiola of *Chaetostylum fresenii*. FIG. 3. Sporangiola (conidia) of *Chaetocladium jonesii*. FIG. 4. Sporangiola (conidia) of *Chaetocladium brefeldii*. FIG. 5. Giant cell found in substrate mycelium of *Chaetocladium brefeldii*.

above eight media all cultures grew to the lid of the dish and produced both sporangia and sporangiola. In general NRRL 2305 did not grow quite as tall but showed more sporulation.

Preuss (1851) described a fungus, *Ascophora pulchra*, which Fischer (1892) stated from his study of Preuss's original material proved to be *Chaetostylum fresenii*. The original description is not sufficiently clear to identify it with any degree of certainty especially since illustrations are not given.

The type species of Klein's genus, *Bulbothamnidium elegans*, is clearly this species as determined from the illustrations. However in Klein's description measurements of spores or other parts are not given. Brefeld (1881) described and splendidly illustrated a mold which is also obviously the above species although he likewise failed to give such important data as the size of the spores. His figure five shows a sporangiophore with a columella at its tip and with simple or compound branches arising in clusters from the sporangiophore and bearing both sporangiola and sterile spines. The sporangiospores are obviously oval to elliptical in shape.

Schroeter (1886) did not recognize the genus *Chaetostylum* and thus transferred van Tieghem and Le Monnier's species into the genus *Thamnidium* as *T. fresenii* (van Tieghem et Le Monnier) Schroeter.

Sorokine (1889) very poorly described a species of *Chaetostylum* and indicated that it was similar to *C. fresenii* except that the sporangiolar walls were echinulate. Since the sporangiolar walls are incrusted in this species, this seems to be quite insufficient grounds for recognizing a new species. Sorokine also reported spore measurements of 2–4.5 μ which are smaller than those recorded by van Tieghem and Le Monnier, and smaller than those observed in our studies. There is some doubt, therefore, about the identity of Sorokine's organism. Fischer (1892) also believed that this might be a synonym of the above species.

Sumstine (1910) transferred *Ascophora pulchra* Preuss into the genus *Bulbothamnidium* and at the same time described a new variety, *B. pulchrum* var. *variabile*. This was considered to be a new variety because the sporangiospores were so variable in size. Considering the variation encountered in studies of the above cultures under defined conditions, this is probably the variation to be expected under different cultural and age conditions. Hence this also is considered to be a synonym of *C. fresenii*.

Naumov (1933) described a second variety named *C. fresenii* var. *macrosporum* which he stated is identical to *C. fresenii* except the sporangiospores are 10.5–16.5 $\times 7$ μ in size. This range in size agrees with the variation observed in our cultures and it also is reduced to synonymy.

EXCLUDED SPECIES

1. *Chaetostylum circinans* Bainier, Bull. Soc. Mycol. Fr. *22:* 211. 1906. This species belongs in the genus *Helicostylum.* The sporangiolar branches are all circinate just as is the case of all species of *Helicostylum.*

2. *Chaetostylum elegans* (Corda) Zycha in Kryptogamenflora der Mark Brandenburg *6a*: 158. 1935. This species is best left in the genus *Helicostylum* where Corda originally placed it. It should be noted that Zycha cited this name *Chaetostylum elegans* (Corda) Bainier. However Bainier did not make this combination, hence Zycha must be credited with it.

3. *Chaetostylum intermedium* Naumov, Clés des Mucorinées p. 60, 1939. This name is listed by Naumov with a very brief description but the exact citation to the original reference is not given. According to Naumov it had sporangia with columellae 95–120 × 75–90 μ and spores 7.5–13.5 × 6–7.5 μ. For the present this species must be considered as too little known to be recognized.

Chaetocladium Fresenius. Beiträge zur Mykologie, p. 97. 1863.

Mycelium slowly to rapidly growing, branched, thin, colorless, usually forming stolons and rhizoids; conidiophores (sporangiophores) repeatedly branched, typically in whorls from the main conidiophore; ultimate whorl of branches short, swollen distally, with very thin short stalks bearing conidia (one-spored sporangiola), with central axis of the whorl extended as a sterile spine; sporangia and more than one-spored sporangiola always absent; conidia globose to spherical, smooth or echinulate; zygospores globose, brown in color, formed between typically unequal suspensors, found in the aerial mycelium; heterothallic; parasitic upon other members of the Mucorales or saprophytic, when parasitic producing gall-like structures on the host, never obligate parasites; sometimes requiring low temperatures for growth.

This genus is closely related to *Chaetostylum* and to *Cunninghamella.* It is similar to *Chaetostylum* in the presence of sterile spines and the manner of the branching of the conidiophores but it differs from *Chaetostylum* by having exclusively one-spored sporangiola and by lacking sporangia completely. It resembles *Cunninghamella,* on the other hand, in the production of conidia if one assumes that the reduced condition of the sporangiola is present in *Cunninghamella* as has been demonstrated in the two members of *Chaetocladium.* The manner in which the zygospores are produced and the lack of sporangia are also to be taken into consideration in noting differences. It differs from *Cunninghamella* in the manner of the branching of the conidiophores and the presence of sterile spines; also, in *Cunninghamella* the existence of a sporangial wall is not apparent.

This genus was placed by van Tieghem (1875) in the Tribe Mucorées. Schroeter (1886), Fischer (1892), and Fitzpatrick (1930) placed it by

itself in the family Chaetocladiaceae. Lendner (1908) placed it in the Chaetocladiaceae along with *Cunninghamella*, *Choanephora*, *Piptocephalis*, *Dispira*, *Syncephalis*, and *Syncephalastrum*.

Zopf (1890) only mentioned the species *Chaetocladium elegans*, but gave no description or illustrations. Since the species name is probably an error it should be considered as a *nomen nudum*.

The type species is *C. jonesii*. The following key separates the two known species.

1. Conidia 7–10 μ in diam., wall roughened ..... *C. jonesii*.
1. Conidia 3–7 μ in diam., wall granular or smooth ..... *C. brefeldii*.

Chaetocladium jonesii (Berkeley et Broome) Fresenius Beiträge zur Mykologie, p. 97. Pl. XII, figs. 5–12. 1863.

1854. *Botrytis jonesii* Berkeley et Broome, Ann. Mag. Nat. Hist., ser. II. *13*: 462.

1881. *Chaetocladium fresenianum* Brefeld, Bot. Unters. u. Schimmelpilze *4*: 55.

1892. *Chaetocladium fresenii* Tavel, Verg. Morph. d. Pilze, p. 36. (*nomen nudum*)

Colonies neutral gray (Ridg.), to 2 cm. high, growing well at 7° C, forming stolons and rhizoids with stolens lax, often collapsing; sporangia absent; conidiophores usually septate, with granular contents, up to 25 μ in diam., mostly 15 μ or less, colored light gray with age, bearing only conidia (one-spored sporangiola); branches arising oppositely or in whorls from the main conidiophore, each branch becoming progressively smaller in diam. and in turn branched similarly several times; penultimate branch with a whorl of short branches, each of which is swollen terminally with many short, sharp-ended stalks upon which the conidia are borne, the central axis of the terminal whorl ending in a sterile spine which tapers to 2 μ in diam.; sporangiola (conidia) single-spored, globose, grayish, echinulate, sometimes showing two distinct membranes, mostly 7–10 μ in diam., with extremes of 5.5–12 μ (fig. 3); substrate mycelium with peg-like cells; chlamydospores unknown; zygospores formed from stolons and mycelium, globose, dark yellow, larger than in *C. brefeldii*, covered with blunt warts; suspensors swollen, approximately equal; heterothallic.

Only one isolate of this species has been seen by us. This was collected by the senior author in a soil sample collected in a hardwood forest at Ferry Bluff near Sauk City, Wisconsin, in 1946. Several other isolates have been obtained from various persons as this species, but these were all incorrectly identified. The Wisconsin isolate is carried as NRRL 2343. Since no zygospores were seen, the above description of the zygospores is taken from Brefeld as given in Fischer (1892).

When the soil sample from which this species was isolated was collected, it was purposely used to inoculate malt extract agar plates, which were incubated at 7° C. Several weeks later one plate showed a practically pure

culture of this fungus. Since it was not known at that time whether it could be grown in pure culture it was immediately studied. The above description is based upon this study and recent studies of the culture growing on SMA. The culture in question covered the entire surface of the agar and was fruiting vigorously, even against the lid of the Petri dish.

Growth of this species is luxuriant upon both PDA and malt extract agar. However upon Czapek solution agar only small white colonies are formed, with no sporulation in one month.

This species was described and illustrated by Berkeley and Broome (1854) who had seen it upon the dung of dogs and rabbits. Their illustrations showed the branching of the conidiophores and the sterile spines which are so characteristic of this genus. The illustrations also showed conidia with slightly echinulate walls. However, they considered their fungus to belong in the genus *Botrytis*. Fresenius erected the genus *Chaetocladium* in 1863 and properly made the new combination *C. jonesii* (Berkeley and Broome) Fresenius, having recognized that Berkeley and Broome had already described the species. Brefeld mistook a smaller and undescribed species for this one and in turn erected a new species *C. fresenianum* for *C. jonesii*. Later Tavel (1892) used the name *Chaetocladium fresenii* apparently for Brefeld's species *C. fresenianum*, which as noted above was based upon an error in identification.

In addition to these records Campbell (1938) reported it from soil. Marchal and Marchal (1921) reported it from fruit, and Zycha (1935) lists a number of additional records.

Chaetocladium brefeldii van Tieghem et Le Monnier, Ann. Sci. Nat. Ser. V. *17*: 342. Pl. 23, figs. 71–79. 1873.

1924. *Chaetocladium brefeldii* var. *macrosporum* Burgeff, Bot. Abhand. *1* (4): 109 (also see Zeits. f. Bot. *12*: 2, 1920.)

Colonies growing on SMA at 20° for 11 days near olive gray to pale mouse gray (Ridg.) but at first white, up to 3 mm. in height; growth rather slow with heaviest growth near the point of inoculation; colonies about 7.5 cm. in diam., with margin irregular, sometimes with marginal colonies from the stolons; colony reverse white to very light yellow near tilleul-buff (Ridg.), but when grown at 25° C reverse may be near deep olive buff with margin pale olive buff (Ridg.); odor faint, like corn meal; stolons always present and showing rhizoidal-like development when in contact with substrate; conidiophores (sporangiophores) arising from stolons, singly or in whorls, also from substrate on poor nutrient media, often roughened by rounded bumps, stiffly erect from the stolons, septate, hyaline, up to 17 μ, rarely to 25 μ in diam.; branches of conidiophores to 225 μ in length, divided as many as four times, typically in whorls but also dichotomously divided, always ultimately ending in an ovoid swelling 4–11 μ in diam. upon which short stalks bear conidia, the branch extended as a spine beyond the swelling; stalks bearing conidia hyaline, and about 1 μ in diam.; spines hyaline, tapering to 1.5 μ in diam. and to 95 μ in length; sporangia and multi-

spored sporangiola absent; conidia globose to very short oval, smooth, hyaline, with contents homogeneous and slightly gray in color, double wall not clearly visible, very constant in size, 4–7 μ in diam., occasionally up to 10 μ in diam. in some strains (fig. 4); no chlamydospores or oidia seen; substrate mycelium very characteristic with peg-like feeding filaments, never with extensive elongate feeder filaments; giant cells present, globose or irregular, contents granular, arising at ends or from side branches of substrate mycelium, up to 170 μ in diam. (fig. 5); zygospores 25–47 μ in diam., light yellow to brown, globose to slightly flattened, surface cerebriform as seen from above, roughened with ridges only and less than 2.5 μ in height, large central oil droplet, granular zone outside the oil droplet and still a more compact zone outside; zygospores formed in clumps on tufts of aerial mycelium that arise from stolons or other aerial mycelium above the substrate, many zygospores not maturing; zygospore-producing hyphae hyaline, smooth-walled, irregularly branched, up to 13 μ in diam.; suspensors light yellow brown in color, typically heterogametic, one greatly swollen to approximate size of mature zygospore, hence 42 μ or more in diam., the other suspensors typically small, both smooth-walled, larger one globose, with granular contents; heterothallic; growth best at 20–25° C but also growth at 7° C; often parasitic on other mucoraceous hosts where gall-like structures are formed, but also free living.

A number of strains of this species have been examined, including NRRL 1350 upon which this description is primarily based. This strain was one labeled *Chaetocladium* var. *macrosporus* from the Blakeslee Collection. Additional typical strains are NRRL 2508 obtained from George Smith and isolated by J. T. Duncan from rat dung, 1937, and strain NRRL 2510 obtained from the Nagao Institute as NI 1235 and originally from the Baarn, Holland, Collection. Still another strain, NRRL 1349, which came from Blakeslee and was originally isolated from horse dung, grows much like NRRL 1350 on SMA at 20° C but at 7° C is sterile and very restricted in appearance thus quite unlike NRRL 1350. NRRL 1349 very rapidly parasitizes other mucors and, as indicated by Burgeff (1920), produces gall-like lesions on the host. It appears much more luxuriant when grown with a host than by itself.

All isolates when grown at 20° C for 7 days on Czapek solution agar gave only a little fruiting at the point of inoculation and the growth was so scant that one could barely see the colony. It may be stated that the amount of branching and hence the number of spores produced is much reduced on poor nutrient media such as hay and Czapek solution agars.

Growth is much more luxuriant on both PDA and malt extract agar. A colony may reach to 0.5 cm. in height on PDA but does not cover the entire surface of the Petri dish. At the point of inoculation there appears to be a heavier white growth but most of the colony is light olive gray (Ridg.) and reverse in yellow shades near pale olive buff.

This species is readily separated from *C. jonesii* by its smaller conidia

with their nearly smooth spore walls. In addition, it does not grow as rapidly at 7° C and never is as vigorous in growth. *C. jonesii* does not show so clearly the peg-like outgrowth of the substrate mycelium as noted for *C. brefeldii*. The lack of thin feeder substrate mycelium was noted by Grehn (1932).

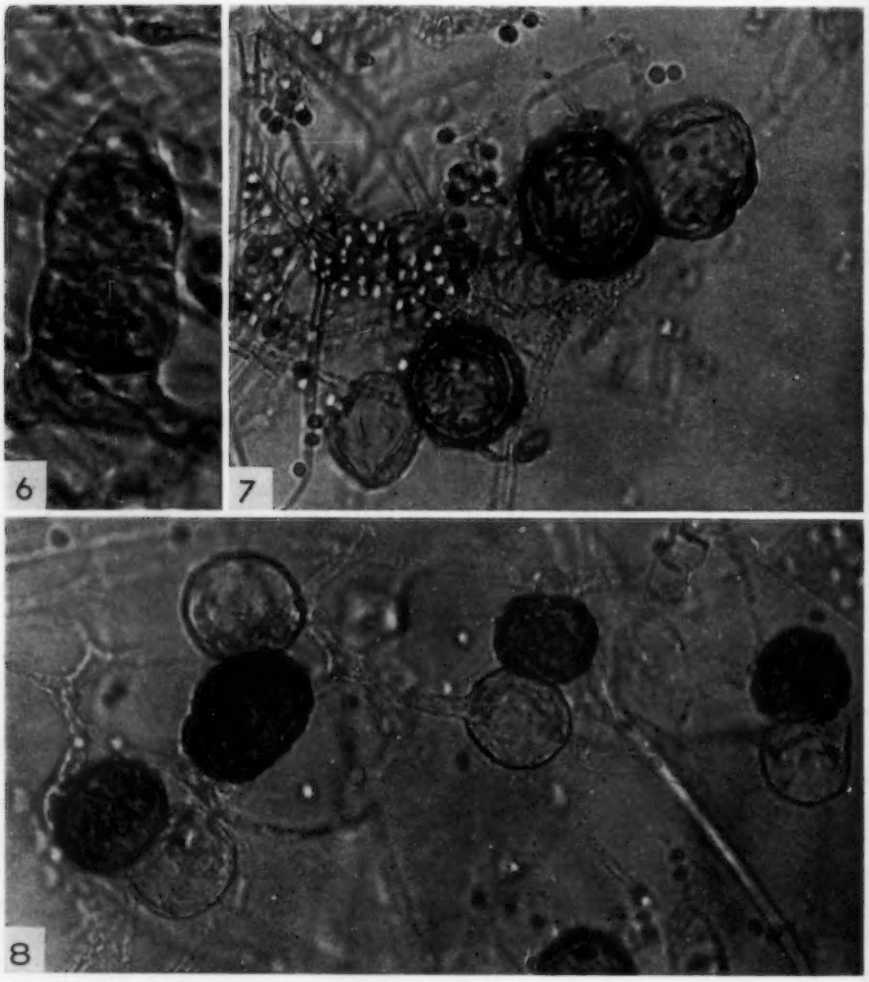
Van Tieghem and Le Monnier (1873) demonstrated that *C. brefeldii* is a facultative parasite upon certain species of the Mucoraceae. This species had been erroneously described earlier by Brefeld (1872) as *C. jonesii;* he gave the conidia size as 1.8–2.3 μ in diameter which is much too small for *C. jonesii*. The true *C. jonesii* was later described by Brefeld (1881) as *C. fresenianum*.

Burgeff (1920) (1924) described a variety of this species called *C. brefeldii* var. *macrosporum* which differed from the typical form in having conidia 4.5–6.2 μ instead of 1.8–3.3 μ. Burgeff's name was actually proposed in his second paper cited above. However, Burgeff was referring to the small spore size given by Brefeld (1872) instead of those given by van Tieghem and Le Monnier who stated the sporangiospores were 3–5 μ. As far as the authors are aware no one has reported the spores to be as small as those given by Brefeld, hence Burgeff, following Brefeld fell into error as to the correct spore size of *C. brefeldii*. Strain NRRL 1350 which came through Blakeslee from the Baarn Collection marked *Chaetocladium* var. *macrosporus* must have been Burgeff's culture for Burgeff's strain is the only one listed in a catalogue of about that time issued by the Baarn Collection. As noted above, NRRL 1350 is a typical representative of the species.

Bainier (1884) beautifully illustrated the zygospores of *C. brefeldii* but gave a very meager description of them. The marking on the zygospore walls and the early stages of their development in his illustration are so characteristic that there is no doubt that he actually was dealing with the perfect state of this species.

After the isolates of *Chaetocladium* had been identified, it appeared that it might be possible to mate the seven strains of *C. brefeldii* and secure zygospores. Our first matings made on various media at 20° C were very successful when sets of three cultures were mated together. It appeared that YpSs medium and Emerson's agar were most successful for the induction of zygospores. It soon was demonstrated that six of the seven strains studied represented two of one sex (+) and four of the other (−). One of the best combinations was NRRL 2510 (−) × NRRL 1350 (+) and NRRL 2509 (+) × NRRL 2508 (−). Our subsequent work was with NRRL 2510 and NRRL 1350. It was found that zygospores were formed readily on the above two media and in addition on yeast extract agar, steep agar and PDA. It was later found that NRRL 2508 × NRRL 2509 was a much more vigorous mating combination. Using Emerson's agar it was discovered that mature zygospores

could be produced from 7° to 26° C. More sexual fusions appeared to fail to develop at the higher temperatures than at the lower. One strain, NRRL 1349, when mated with both plus and minus cultures failed to produce zygospores except in one case with NRRL 2510. Since this could never be



FIGS. 6–8. FIG. 6. Early stage in zygospore formation of *Chaetocladium brefeldii*. FIG. 7. Mature zygospores of *Chaetocladium brefeldii* showing the markings upon the surface of the zygospores. FIG. 8. Mature zygospores of *Chaetocladium brefeldii* showing the large and small suspensors.

duplicated, this strain should be considered as neutral. However, it cannot be considered to represent another variety on the available information even though it is slightly different in growth as noted above. When isolates of this

species were mated with *C. jonesii*, NRRL 2343, no evidence of zygospore formation was observed.

When opposite mating types are paired in the usual fashion on Emerson's agar, the colonies grow together, and shortly thereafter tufts of much branched aerial mycelium arise near the point of contact between the colonies. This may occur in less than 6 days at 20° C. In some cases this may be much nearer one colony than the other. These tufts show much-branched and recurved hyphae with large numbers of progametangia. Fusion occurs in the normal fashion of the Mucorales (fig. 6), and a zygospore is formed. At the time the progametangia come into contact they are equal in size but, as the zygospore is formed, typically one suspensor swells enormously to become globose and slightly yellow or yellow brown in color (fig. 8). Its size is usually almost as large as that of the zygospore. When cultures are exposed to drying, these large suspensors rapidly collapse. The other suspensor may enlarge but typically never reaches even half the size of the larger. A typical mature zygospore measuring 40 μ in diam. had the larger suspensor measuring 37 μ in diam. and a smaller one 15 μ in diam. Mature zygospores are yellow to yellow brown in color and marked by irregular ridges (fig. 7). At first they contain numerous oil droplets which later coalesce into one large droplet. However, at 20° C many of the fusions of progametangia never develop to maturity. This is particularly true of those borne higher above the substrate.

In the mating reaction between even strong mating types the tufts of aerial mycelium never result in a distinct dark line of zygospores across the plate. However, the region at the line of contact may be seen to take on a lighter color owing to the tufts of sexually reproducing hyphae. With age, the stolons and conidiophores overgrow the zone of zygospore formation and one must search near the substrate to find the mature zygospores.

Summary

1. *Chaetostylum* and *Chaetocladium* are recognized as valid genera. *Chaetostylum* is considered to be monotypic while *Chaetocladium* is believed to contain two distinct species.

2. The synonymy and history of these genera and species are given.

3. Conditions for producing zygospores and a description of them are given for the genus *Chaetocladium*.

4. All species described above grow at 7° C, and two of the three species will not grow well above 20° C.

Northern Utilization Research Branch, Agricultural Research Service
U. S. Department of Agriculture; Peoria, Illinois

Literature Cited

Bainier, G., 1884. Nouvelles observations sur les zygospores des Mucorinées. Ann. Sci. Nat. Bot., Ser. VI **19**: 200–216.

————, 1906. Mycothèque de l'Ecole de Pharmacie IV. Observations sur l'*Helicostylum elegans* (Corda). Bull. Soc. Mycol. Fr. **22**: 210–212.

Barnett, H. L. & Lilly, V. G. 1950. Influence of nutritional and environmental factors upon asexual reproduction of *Choanephora cucurbitarum* in culture. Phytopath. **40**: 80–89.

Berkeley, M. J. & Broome, C. E. 1854. Notices of British fungi. Ann. Mag. Nat. Hist., Ser. II. **13**: 458–469.

Bidault, C. 1921. Sur les moissures des viandes congelées. Compt. rend. Soc. d. biol., Paris. **85**: 1017–1018.

Brefeld, C., 1872. Botanische Untersuchungen über Schimmelpilze. **1**: 1–64.

————, 1881. Botanische Untersuchungen über Schimmelpilze. **4**: 55–59.

Brooks, F. T. & Hansford, C. G. 1923. Mould growth upon cold stored meat. Trans. Brit. Mycol. Soc. **8**: 113–142.

————, & Kidd, M. N. 1921. The "black spot" of chilled and frozen meat. Dept. of Sci. and Ind. Res., Food Invest. Board, Special Rept. No. 6. 6 p.

Burgeff, H., 1920. Über den parasitismus des *Chaetocladium* und die heterocaryotische Natur der von ihm auf Mucorineen erzeugten Gallen. Zeits. f. Bot. **12**: 1–35.

————, 1924. Untersuchungen über Sexualität und Parasitismus bei Mucorineen I. Bot. Abhand. **1** (4): 1–135.

Campbell, M. E., 1938. An investigation of the Mucorales in the soil. Trans. Roy. Soc. Edinburgh **59**: 411–436.

Christiakoff, F. M. & Bacharova, Z. 1938. The influence of low temperatures on microorganisms on mould development. Microbiol. **7**: 498–514, 838–842. (See Rev. Appl. Mycol. **18**: 467. 1939).

Emerson, R. & Wilson, C. M. 1954. Interspecific hybrids and the cytogenetics and cytotaxonomy of Euallomyces. Mycologia **46**: 393–434.

Empey, W. A. & Scott, W. J. 1939. Investigations on chilled beef. I. Microbial contamination acquired in the meat works. II. Cooling and storage in the meat works. Austral. Council Sci. and Ind. Res. Bull. **126**: 1–71 and **129**: 1–68.

Fischer, A., 1892. Phycomycetes: Mucorinae. In Rabenhorst's Kryptogamen-Flora Deutschl. Oest. u.d. Schweiz. **1** (4): 161–310.

Fitzpatrick, H. M., 1930. The Lower Fungi. Phycomycetes. New York.

Fresenius, G., 1863. Beiträge zur Mykologie, 97–99.

Grehn, J., 1932. Untersuchungen über Gestalt und Funktion der Sporangienträger bei den Mucorineen. I. Entwicklungsgeschichte der Sporangienträger. Jahrb. Wiss. Bot. **76**: 93–165.

Gisshe, H. W., 1937. Über die für die Verderbnis von in Kuhlhaüsern eingelagerten Eiern wichtigen Schimmelpilze unter besonderer Berücksichtigung des Schimmelpilzehaltes der Kühlhausluft. Vet.-med. Diss., Hanover, 1937. (Rev. Appl. Mycol. **17**: 321. 1938.)

Haines, R. B. & Smith,, E. C. 1933. The storage of meat in small refrigerators. Dept. of Sci. and Ind. Res. Food. Invest. Board, Special Rept. **43**: 30 p.

Hesseltine, C. W. & Fennell, D. 1955. The genus *Circinella*. Mycologia **47**: 193–212.

———— **& Anderson, P.** 1956. The genus *Thamnidium* and a study of the formation of its zygospores. Am. J. Bot. **43**: 696–703.

Jensen, L. B., 1954. Microbiology of meats. Third ed. Champaign, Illinois.

Klein, J., 1870. Mykologische Mittheilungen. Verh. Zool.-Bot. Ges. Wien **20**: 547–570.

Lendner, A., 1908. Les Mucorinées de la Suisse. 180 p.

Marchal, E. & Marchal, Em. 1921. Contribution á l'étude des champignons fructicoles de Belgique. Bull. d. l. Soc. Roy. d. Bot. d. Belg. **44**: 31 p.

Moran, T., Smith, E. C. & Tompkins, R. G. 1932. The inhibition of mould growth upon meat by carbon dioxide. J. Soc. Chem. Ind. **51**: 114T–115T.

Naumov, N. A., 1939. Clés des Mucorinées. Paris.

Preuss, G. T., 1851. Uebersicht untersuchter Pilze, besonders aus der Umgegend von Hoyerswerda. Linnaea **24**: 129–153.

Ridgway, R. 1912. Color standards and color nomenclature. Pls. 1–53. Washington, D. C.

Schroeter, J., 1886. Mucorinei. In Cohn's Kryptogamen-Flora von Schlesien **3** (2): 198–217.

————, 1897. In Engler and Prantl's Die Natürlichen Pflanzenfamilien. Mucorineae **1** (1): 119–134.

Semeniuk, G. & Bell, W. C. 1937. Some moulds associated with meat in cold storage lockers in Iowa. Proc. Iowa Acad. Sci. **44**: 37–43.

Sorokine, N., 1889. Materiaux pour la Flore cryptogamique de l'Asie Centrale. Rev. Mycol. **11**: 136–152.

Sumstine, D. R., 1910. The North American Mucorales I. Family Mucoraceae. Mycologia **2**: 125–154.

Tavel, F. von, 1892. Vergleichende Morphologie der Pilze. 35–36.

Tompkins, R. G., 1933. Mycology. The inhibition of the growth of meat attacking fungi by carbon dioxide. Dept. Sci. and Ind. Res., Rept. Food Invest. Board for the year 1932. 48–50.

van **Tieghem, P.**, 1875. Nouvelles recherches sur les Mucorinées, Ann. Sci. Nat., Ser. VI. **1**: 5–175.

———— **& Le Monnier, G.** 1873. Recherches sur les Mucorinées. Ann. Sci. Nat., Ser. V. **17**: 261–399.

Wolf, F. T. & Wolf, F. A. 1950. Chemical agents for the control of molds on meat. Mycologia **42**: 344–366.

Zopf, W., 1890. Die Pilze In Schenk's Handbuck der Botanik **4**: 373.

Zycha, H., 1935. Mucorineae. Kryptogamenflora der Mark Brandenburg **6a**: 1–264.

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A NEW LISIANTHUS FROM GUATEMALA

PAUL C. STANDLEY AND JULIAN A. STEYERMARK

In studying material of *Lisianthus* in the United States National Herbarium, the junior author encountered a specimen which could not be placed in any existing species. Study of this specimen has indicated that it represents the following undescribed taxon:

Lisianthus petenensis Standl. & Steyerm., sp. nov. Herba erecta ramosa glabra, ramis teretibus gracilibus viridibus, internodiis superioribus plerumque foliis brevioribus; foliis breviter petiolatis vel subsessilibus, in sicco crassis, petiolis alatis 2–3 mm. longis; laminis ovatis vel oblongo-ovatis 3–6.5 cm longis 1.5–2 cm. latis acuminatis, basi obtusis vel subacutis, costa impressa, nervis occultis, subtus fere concoloribus, aliis lateralibus nullis; floribus in cymis axillaribus umbellato-aggregatis brevipedunculatis paucifloris vel multifloris 3.5–5 cm. longis, bracteis paucis subulatis 2.5–4 mm. longis, pedicellis angulatis, 2–3 mm. longis; calyce 5-carinato 8–10 mm. longo ad medium vel profundius lobato, segmentis lineari-lanceolatis longe angusteque attenuatis; corolla 27–31 mm. longa, tubo tenui valde constricto in sicco roseo-rubro infra stramineo supra ampliato, fauce 4–5 mm. lato, lobis in sicco rosaceis vel viridi-luteis ovatis 6–6.5 mm. longis caudato-acuminatis; staminibus tubo corollae longioribus, exsertis lobos corollae aequantibus vel fere aequantibus; stylo exserto.

Guatemala: Nictún, Lake Petén, Dept. Petén, May 4, 1933, *C. H. Lundell 3153* (type in U. S. Nat. Herb.).

This species is characterized by the axillary, closely flowered, subumbellate, short-pedunculate cymes with short pedicels, rose-red and greenish yellow corollas, and exserted stamens. In its congested cymes it somewhat resembles *L. brevidentatus* (Hemsl.) O. Ktze., but that species has yellow or yellow-green corollas which are either smaller or have rounded lobes. In color of corolla it approaches *L. axillaris* (Hemsl.) O. Ktze., but that species has longer corollas, flowers solitary or in 2–3 flowered cymes, and much longer pedicels.

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TORREYA

Cynanchum in The New York Area

JOSEPH MONACHINO

Two species of *Cynanchum* are described by Fernald, 8th Ed. Gray's Manual, *C. nigrum* (L.) Pers., twining, flowers dark purple, corolla pubescent within, and *C. Vincetoxicum* (L.) Pers., suberect, flowers greenish white, corolla glabrous. The former species is not rare in the N. Y. metropolitan area (e.g. MONACHINO 574, Pelham Bay Park, Bronx, July 29, 1956, abundant in several places). Recently I studied a species of *Cynanchum* found on the Old Croton Aqueduct, near Hastings-on-Hudson, Westchester Co., N. Y. (M. 573, July 22, 1956) and also in and near the old abandoned rock garden in the N. Y. Botanical Garden (M. 575, July 30, 1956), which is like *C. nigrum* in its strongly twining habit and in its foliage, but differs greatly in its flowers. The corollas are light maroon or pinkish tan, the lobes glabrous, elliptic-lanceolate, about twice as long as broad, while in *C. nigrum* the flowers are black-purple, the lobes white papillose-hirtellous within, broadly deltoid-ovate, about as broad as long; the staminal corona is strongly 5-lobed, the lobes are almost distinct, being united by a membrane only near their base, whereas in *C. nigrum* the crown is crateriform, weakly 5-lobed and with five additional teeth or points in between the principal lobes. The species in question is illustrated by Reichenbach, Icones Germ. (1855), who called it *Vincetoxicum fuscatum*, and compared it with *V. nigrum* on the same plate; another good colored illustration appears under the same name in Jordan & Fourreau, Ic. Fl. Eur. (1867). It has been cultivated and is given in Bailey's Hortus Second (1949) as *Cynanchum fuscatum;* there is an entry in the Bulletin of the New York Botanical Garden for 1900 that *C. fuscatum* was introduced in the Herbaceous Grounds of the Garden.

Considering the synonymy that has appeared in various works, the best choice of name for the species seems to be *Cynanchum medium* R. Br., Mem. Wern. Soc. 1: 48. 1811 (read 1809). Brown aptly placed his species between *C. Vincetoxicum* and *C. nigrum*, suggesting proximity to the latter; he noted the beardless corolla. Decaisne (DC. Prod. 8: 523. 1844) gave a fuller description for it, which he called *Vincetoxicum medium*. *Cynanchum fuscatum* Link (1821) was described as having a yellow corolla; *Asclepias fuscatum* Willd. (1813) was listed without description. *Cynanchum luteum* Steud. (1821) and *Vincetoxicum luteum* Hoffmgg. & Link (1809) were based on *Asclepias lutea* Mill. (1768), which was described as having yellow flowers and suggests some form of *C. Vincetoxicum*. *Cynanchum fuscum* Schult. (1820) was based on *Asclepias fusca* Lour. (1790), an Asiatic species having nothing to do with our plant (it may be a *Tylophora* according to E. D. Merrill).

Incidentally, while on the subject of nomenclature, I must point out that the well-known binomial *Cynanchum nigrum* (L.) Pers. (Syn. 1: 270. 1805) is a later homonym of *Cynanchum nigrum* Cav. (Ic. 2: 45, t. 159. 1793)! According to Article 74 of the International Code, the later homonym must be rejected. The search for the legitimate binomial for the European plant would be greatly involved. There is a *Cynanchum barbatum* Breit. (Hortus Breiterianus, p. 112. 1817), which was listed with *C. nigrum* Pers. and *Asclepias nigra* L. in synonymy. Breiter credited the name to "L. Suppl.," but I could not find any *C. barbatum* in Linnaeus' Suppl. Plant. Syst. Veg. (1781) or in other works prior to 1817, and I can't explain the citation.

C. medium is amply distinct from *C. nigrum*, although the distinction can be seen in the flowers only; but I am uncertain as to how clearly it can be separated from some other European species. In the matter of name priority we need not be concerned except for *C. Vincetoxicum;* but inspection of the herbarium material of the latter, the widest spread Cynanchum in Europe, shows how variable it is in its coronal development and

other details, and leads one to wonder how significant the differences between *C. medium* and *C. Vincetoxicum* may be. I have examined herbarium specimens of European *C. Vincetoxicum* that have tiny secondary teeth between the five corona lobes, and also specimens with corolla pubescent within; Coste (Fl. France, 1903) described the species as having the corolla lobes rarely pubescent. Hegi (Ill. Fl. Mit. Eur., 1926) noted the polymorphism of *C. Vincetoxicum;* he described a form two meters tall (*f. scandens*) and a purple flowered variety. The specimen collected by E. P. Bicknell in Queens Co., L. I., May 30, 1913, determined by Britton as *C. Vincetoxicum* and reported as such by Taylor in his Flora of the Vicinity of New York, probably had fuscous flowers. There is a problem even with living plants close at hand, for in the grounds of the New York Botanical Garden there are specimens growing with and resembling *C. medium*, twining, but having greenish white flowers (M. 576, July 30, 1956; *Charles Gilly 380*, N.Y.B.G., Aug. 12, 1940, distributed as *C. Vincetoxicum*, is probably the same).

C. medium also has been collected in Pennsylvania (*E. T. Wherry*, one half mile ne. Frogtown, York Co., June 23, 1929, abundant in fencerow thicket), distributed as *C. nigrum*. The N. Y. sheet is one of three different "*C. nigrum*" collections stamped "This specimen used for illustration Ed. 3 Britton & Brown's Flora." Does this explain the incorrect enlarged figure of the flower of *C. nigrum* in Gleason's New Britton and Brown? The figure shows the "glabrous" corolla lobes about thrice as long as wide, contradicting the correct dimensions given in the key, nearly as wide as long. However, in this instance I do not believe it possible to prove whether the error was due to misidentfiied material or to inaccurate drawing.

Taylor (Fl. Vic. N. Y., 1915) noted *C. acutum* L. on ballast near Cummunipaw, N. J. (a sterile specimen, *Addison Brown*, Sept. 20, 1880). This record was ignored, reasonably enough, by both Fernald and Gleason.

The present article is the first to report *C. medium* growing spontaneously in the New World. The species so resembles *C. nigrum* that it has been confused with it even in the herbarium of European specimens. Flowers are essential to distinguish the two. Now that we are alerted, it remains to be seen how frequently *C. medium* is discovered in the range of the Torrey Botanical Club.

An Annotated Preliminary Catalogue of the Vascular Flora of Rockland County, New York

(Continued from Bull. Torrey Club 83: 435–438. 1956.)

J. HARRY LEHR

PINACEAE

TSUGA

TSUGA CANADENSIS (L.) Carr. Eastern Hemlock. General. The most common evergreen in the County.

LARIX

*LARIX DECIDUA Mill. European Larch. Ramapo. An isolated adventive.
*L. LARICINA (DuRoi) K. Koch. Tamarack. Ramapo.

PINUS

*PINUS RIGIDA Mill. Pitch Pine. Ramapo.
*P. STROBUS L. Eastern White Pine. General.
*P. SYLVESTRIS L. Scotch Pine. Ramapo. An introduction tending to become naturalized.

JUNIPERUS

JUNIPERUS VIRGINIANA L. var. CREBRA Fern. & Grisc. Eastern Red-cedar. General. (H)

TYPHACEAE

Typha

Typha angustifolia L. Narrow-leaved Cat-tail. Orangetown, Haverstraw, Stony Point. (H)

T. latifolia L. Common Cat-tail. General. (H)

SPARGANIACEAE

Sparganium

*Sparganium androcladum (Engelm.) Morong. Branching Bur-reed. Ramapo.

*S. eurycarpum Engelm. Great Bur-reed. Haverstraw, Clarkestown. (H)

ZOSTERACEAE

Potamogeton

*Potamogeton pectinatus L. Sago. Haverstraw. (H)

ALISMATACEAE

Alisma

Alisma subcordatum Raf. Common Water-plantain. General. (H)

Sagittaria

Sagittaria latifolia Willd. Broad-leaved Arrowhead. General.

*S. latifolia Willd. forma gracilis (Pursh) Robins. General. This form is usually found growing with the typical species.

GRAMINEAE

Bromus

*Bromus secalinus L. Chess. Ramapo. (H)

Glyceria

Glyceria canadensis (Michx.) Trin. Rattlesnake Mannagress. Ramapo, Haverstraw. (H)

Dactylis

Dactylis glomerata L. Orchard Grass. General. (H)

Eragrostis

*Eragrostis megastachya (Koel.) Link. Stinkgrass. Orangetown. (H)

E. spectabilis (Pursh) Steud. Purple Lovegrass. Orangetown. (H)

*E. spectabilis (Pursh) Steud. var. sparsihirsuta Farw. Clarkestown. (H)

Triodia

Triodia flava (L.) Smyth. Purpletop. General. (H)

Distichlis

Distichlis spicata (L.) Greene. Seashore Saltgrass. Orangetown.

Phragmites

Phragmites communis Trin. var. Berlandieri (Fourn.) Fern. Common Reed. General. (H)

Agropyron

*Agropyron repens (L.) Beauv. forma Vaillantianum (Wulf & Schreb.) Fern. Quack-grass. Ramapo. (H)

LOLIUM

*LOLIUM MULTIFLORUM Lam. var. DIMINUTUM Mutel. Italian Ryegrass. Clarkestown. (H)

ELYMUS

ELYMUS CANADENSIS L. Canada Wild-rye. Ramapo.
E. VIRGINICUS L. Virginia Wild-rye. Stony Point. (H)

HYSTRIX

HYSTRIX PATULA Moench. Bottlebrush. Stony Point. (H)

ARRHENATHERUM

ARRHENATHERUM ELATIUS (L.) Mert. & Koch. Tall Oatgrass. Ramapo. (H)

HOLCUS

HOLCUS LANATUS L. Velvet Grass. Ramapo. (H)

CALAMAGROSTIS

CALAMAGROSTIS CANADENSIS (Michx.) Nutt. Bluejoint. Stony Point.

AGROSTIS

*AGROSTIS PERENNANS (Walt.) Tuckerm. var. AESTIVALIS Vasey. Autumn Bent. Rampo.

CINNA

CINNA ARUNDINACEA L. Stout Woodreed. Orangetown.

PHLEUM

*PHLEUM PRATENSE L. Timothy. General. (H)

MUHLENBERGIA

MUHLENBERGIA SCHREBERI J. F. Gmel. Nimblewill. Orangetown.
M. SOBOLIFERA (Muhl.) Trin. Orangetown.

BRACHYELYTRUM

BRACHYELYTRUM ERECTUM (Schreb.) Beauv. Ramapo.

ORYZOPSIS

ORYZOPSIS RACEMOSA (Sm.) Ricker. Ramapo. (H)

SPARTINA

SPARTINA ALTERNIFLORA Loisel. Smooth Cordgrass. Orangetown. The author believes that the stations for this species, and the two following ones are the northernmost in New York State. (H)
S. CYNOSUROIDES (L.) Roth. Big Cordgrass. Orangetown, Stony Point. (H)
S. PATENS (Ait.) Muhl. Saltmeadow Cordgrass. Orangetown.
S. PECTINATA Link. Prairie Cordgrass. Orangetown. (H)

ELEUSINE

ELEUSINE INDICA (L.) Gaertn. Goosegrass. Orangetown.

PHALARIS

PHALARIS ARUNDINACEA L. Reed Canary Grass. Ramapo.
*P. ARUNDINACEA L. forma VARIEGATA (Parnell) Druce. Ribbon Grass. Ramapo. (H)

ANTHOXANTHUM

ANTHOXANTHUM ODORATUM L. Sweet Vernalgrass. Ramapo. (H)

LEERSIA

LEERSIA ORYZOIDES (L.) Sw. Rice Cutgrass. Haverstraw.
L. VIRGINICA Willd. var. OVATA (Poir.) Fern. Whitegrass. Ramapo.

ZIZANIA

ZIZANIA AQUATICA L. Annual Wildrice. Orangetown, Stony Point. (H)

DIGITARIA

DIGITARIA FILIFORMIS (L.) Koel. Ramapo. (H)
D. ISCHAEMUM (Schreb.) Muhl. Smooth Crabgrass. General. (H)
D. SANGUINALIS (L.) Scop. Crabgrass. General. (H)

PANICUM

PANICUM BOSCII Poir. Orangetown.
P. CLANDESTINUM L. Ramapo. (H)
*P. DICHOTOMIFLORUM Michx. var. GENICULATUM (Wood) Fern. Fall Panicum. Orangetown.
*P. VIRGATUM L. Switchgrass. Ramapo, Orangetown, Stony Point. (H)

ECHINOCHLOA

ECHINOCHLOA CRUSGALLI (L.) Beauv. Barnyard Grass. Ramapo, Clarkestown. (H)
*E. PUNGENS (Poir.) Rydb. Ramapo. (H)
*E. PUNGENS (Poir.) Rydb. var. MICROSTACHYA. Ramapo. (H)
E. WALTERI (Pursh) Nash. Orangetown. (H)
*E. WALTERI (Pursh) Nash forma LAEVIGATA Wieg. Ramapo. (H)

SETARIA

*SETARIA GLAUCA (L.) Beauv. Yellow Bristlegrass. General.
S. VIRIDIS (L.) Beauv. Green Bristlegrass. General.

CENCHRUS

*CENCHRUS LONGISPINUS (Hack.) Fern. Field Sandbur. Ramapo, Stony Point. (H)

MISCANTHES

*MISCANTHES SINENSIS Anderss. Eulalia. Clarkestown, Ramapo. An introduction not naturalizing at either station. (H)

ANDROPOGON

ANDROPOGON SCOPARIUS Michx. Little Bluestem. Ramapo. (H)
*A. VIRGINICUS L. Broomsedge. Ramapo. (H)

CYPERACEAE

CYPERUS

*CYPERUS FILICULMIS Vahl. Slender Cyperus. Ramapo. (H)
*C. FILICULMIS Vahl. var. MACILENTUS Fern. Ramapo.
*C. FLAVESCENS L. var. POAEFORMIS (Pursh) Fern. Yellow Cyprus. Orangetown, Clarkestown.
C. ODORATUS L. Coarse Cyperus. Orangetown. A single station.
C. STRIGOSUS L. Straw-colored cyperus. General. (H)

DULICHIUM

DULICHIUM ARUNDINACEUM (L.) Britt. Three-way Sedge. Ramapo, Haverstraw. (H)

ELEOCHARIS

*ELEOCHARIS OBTUSA (Willd.) Schultes. Blunt Spike-rush. Ramapo. (H)
*E. PALUSTRIS (L.) R. & S. Creeping Spike-rush. Haverstraw. (H)
E. SMALLII Britt. Haverstraw. (H)

BULBOSTYLIS

BULBOSTYLIS CAPILLARIS (L.) C. B. Clarke. Ramapo. (H)

FIMBRISTYLIS

*FIMBRISTYLIS AUTUMNALIS (L.) R. & S. var. MUCRONULATA (Michx.) Fern. Clarkestown. (H)

SCIRPUS

SCIRPUS ACUTUS Muhl. Western Bulrush. Orangetown.
S. AMERICANUS Pers. Chair-makers Rush. Orangetown. (H)
*S. ATROVIRENS Willd. Dark Green Bulrush. Ramapo.
S. CYPERINUS (L.) Kunth. Wool Grass. Ramapo.
S. ROBUSTUS Pursh. Salt-marsh Bulrush. Orangetown. (H)
*S. RUBRICOSUS Fern. Ramapo.
*S. SMITHII Gray forma SETOSUS Fern. Smith's Club Rush. Ramapo. Almost assuming the habit of a weed at this, its only station. (H)
S. VALIDUS Vahl var. CREBER Fern. American Great Bulrush. Ramapo.

ERIOPHORUM

*ERIOPHORUM TENELLUM Nutt. Rough Cotton Grass. Haverstraw. (H)
*E. VIRGINICUM L. Virginia Cotton Grass. Haverstraw. (H)

RHYNCHOSPORA

*RHYNCHOSPORA ALBA (L.) Vahl. White Beaked-rush. Haverstraw. The three foregoing species are found only in the Ramapo Mountain bogs at an altitude of about 1200 feet. (H)

CAREX

*CAREX AESTIVALIS M. A. Curtis. Summer Sedge. Ramapo. The author believes this is the southernmost station in New York State. (H)
C. BROMOIDES Schkuhr. Broome-like Sedge. Ramapo. (H)
*C. BICKNELLII Britt. Bicknell's Sedge. Ramapo. (H)
*C. CEPHALOPHORA Muhl. Southern Sedge. Ramapo. (H)
*C. COMOSA Boott. Bristly Sedge. Haverstraw. (H)
C. CONVOLUTA Mackenz. Ramapo. (H)
C. CRINITA Lam. Sickle Sedge. Haverstraw, Ramapo. (H)
*C. CRINITA Lam. var. GYNANDRA (Schwein.) Schwein. & Torr. Nodding Sedge. Ramapo. (H)
*C. DIGITALIS Willd. Slender Wood Sedge. Ramapo. (H)
*C. FOLLICULATA L. Long Sedge. Haverstraw.
*C. GRACILLIMA Schwein. Graceful Sedge. Ramapo. (H)
*C. GRANULARIS Muhl. Meadow Sedge. Ramapo. (H)
*C. HIRSUTELLA Willd. Northern Hirsute Sedge. Clarkestown. (H)
*C. HYSTRICINA Muhl. Porcupine Sedge. Ramapo. (H)
*C. INTUMESCENS Rudge. Bladder Sedge. General. (H)
C. LUPULINA Muhl. Hop Sedge. Ramapo. (H)
C. LURIDA. Wahlenb. Sallow Sedge. General. (H)

C. PENSYLVANICA Lam. Pennsylvania Sedge. Clarkestown. (H)
*C. PENSYLVANICA Lam. var. DISTANS Peck. General. This variety is more common in the County than the typical species. (H)
*C. PLATYPHYLLA Carey. Broad-leaved Sedge. Orangetown. (H)
*C. PRASINA Wahlenb. Drooping Sedge. Ramapo. (H)
*C. PROJECTA Mackenz. Necklace Sedge. Ramapo. (H)
*C. RADIATA (Wahlenb.) Dew. Stellate Sedge. Ramapo. (H)
*C. RETROFLEXA Muhl. Reflexed Sedge. Clarkestown. (H)
C. ROSEA Schkuhr. Ramapo. (H)
*C. SCABRATA Schwein. Rough Sedge. Ramapo. (H)
*C. SCOPARIA Schkuhr. Pointed Broom Sedge. Ramapo. (H)
C. STIPATA Muhl. Awl-fruited Sedge. Stony Point. (H)
C. STRICTA Lam. Tussock Sedge. General. The most common sedge in the County.
*C. TORTA Boott. Twisted Sedge. Stony Point. A single station which the author believes is the most southern one in New York State. (H)
*C. VESTITA Willd. Velvet Sedge. Ramapo. A single station for a species which is widely scattered in New York State. (H)
C. VIRESCENS Muhl. Ribbed Sedge. Ramapo. (H)
*C. VULPINOIDEA Michx. Fox Sedge. Ramapo. (H)

ARACEAE

ARISAEMA

ARISAEMA ATRORUBENS (Ait.) Blume. Jack-in-the Pulpit. General. (H)
*A. STEWARDSONII Britt. Stewardson's Jack-in-the-Pulpit. Stony Point. (H)

PELTANDRA

PELTANDRA VIRGINICA (L.) Schott & Endl. Arrow Arum. Stony Point. (H)

CALLA

*CALLA PALUSTRIS L. Wild Calla. Haverstraw. Found only in the Ramapo Mountain bogs at an altitude of about 1200 feet. (H)

SYMPLOCARPUS

SYMPLOCARPUS FOETIDUS (L.) Nutt. Skunk-cabbage. General. (H)

ACORUS

*ACORUS CALAMUS L. Sweetflag. General. (H)

LEMNACEAE

LEMNA

LEMNA MINOR L. Lesser Duckweed. General. (H)

COMMELINACEAE

COMMELINA

COMMELINA COMMUNIS L. Dayflower. Ramapo. (H)
C. COMMUNIS L. var. LUDENS (Miquel) C. B. Clarke. Clarkestown. (H)

TRADESCANTIA

*TRADESCANTIA VIRGINIANA L. Spiderwort. Ramapo. A rare escape in this County. (H)

PONTEDERIACEAE

PONTEDERIA

PONTEDERIA CORDATA L. Pickerelweed. Ramapo, Stony Point.

JUNCACEAE

JUNCUS

*JUNCUS ACUMINATUS Michx. Sharp-fruited Rush. Ramapo. (H)
J. CANADENSIS J. Gay. Canada Rush. General. (H)
*J. DEBILIS Gray. Weak Rush. Haverstraw. A rarity in New York State. (H)
*J. EFFUSUS L. var. SOLUTUS Fern. & Wieg. Common Rush. General. (H)
J. MARGINATUS Rostk. Grass-leaved Rush. Ramapo.
*J. SECUNDUS Beauv. Secund Rush. Clarkestown. (H)
*J. TENUIS Willd. Slender Yard Rush. General. The most common rush in the County. (H)

LUZULA

LUZULA MULTIFLORA (Retz) Lejeune. Common Wood Rush. General. (H)

LILIACEAE

MELANTHIUM

*MELANTHIUM VIRGINICUM L. Bunchflower. Clarkestown. *M. hybridum* has been reported from this County but the author has been unable to relocate it. Instead, he has found this previously unreported species at a single station. (H)

VERATRUM

VERATRUM VIRIDE Ait. False Hellebore. General. Although common throughout the County it is rarely found flowering.

UVULARIA

UVULARIA PERFOLIATA L. Perfoliate Bellwort. Ramapo. (H)
U. SESSILIFOLIA L. Sessile-leaved Bellwort. Ramapo. (H)

ALLIUM

ALLIUM CANADENSE L. Wild Garlic. Ramapo, Clarkestown. (H)
*A. TRICOCCUM Ait. Wild Leek. Ramapo. The author has found two well marked varieties of this species at this station, a finding in complete agreement with Hanes' Michigan report (see Rhod. **48**: 61–63, 1946.) (H)
A. VINEALE L. Field Garlic. General. (H)

HEMEROCALLIS

*HEMEROCALLIS FLAVA L. Yellow Day-Lily. Ramapo. A rare escape in this County. (H)
H. FULVA L. Common Day-Lily. General. One of the common roadside flowers of this County. (H)

HOSTA

*HOSTA JAPONICA (Thumb.) Voss. Narrow-leaved Plantain-Lily. Ramapo. An escape at a single station. (H)
*H. VENTRICOSA (Salisb.) Stearn. Blue Plantain-Lily. Stony Point. Naturalized at this, its only station. (H)

LILIUM

LILIUM CANADENSE L. Wild Yellow Lily. Clarkestown, Ramapo. (H)
L. PHILADELPHICUM L. Wood Lily. Clarkestown. A single station.

ERYTHRONIUM

ERYTHRONIUM AMERICANUM Ker. Dog's-tooth Violet. Races with yellow anthers and brown-red anthers have been found in the areas studied. General. (H)

Ornithogalum

Ornithogalum umbellatum L. Star-of-Bethlehem. Ramapo, Clarkestown. Naturalized at each of its stations. (H)

Asparagus

*Asparagus officinalis L. Garden Asparagus. Ramapo.

Clintonia

Clintonia borealis (Ait.) Raf. Yellow Clintonia. Ramapo. The author has had this colony under observation for the past four years. The colony consists of about one hundred plants none of which have flowered at any time during that period. They grow at an altitude of about 1100 feet. (H)

Smilacina

Smilacina racemosa (L.) Desf. False Solomon's Seal. General. (H)
*S. racemosa (L.) Desf. var. cylindrata Fern. Ramapo. (H)
*S. trifolia (L.) Desf. Three-leaved Solomon's-Seal. Haverstraw. Like *Clintonia borealis*, the plants at this, the only station, have not flowered in the three years that they have been under observation by the author. The plants grow at an altitude of about 1200 feet and the author believes it is the most southern station in the State. (H)

Maianthemum

Maianthemum canadense Desf. Two-leaved Solomon's-Seal. General. (H)

Polygonatum

Polygonatum biflorum (Walt.) Ell. Smooth Solomon's-Seal. Ramapo. (H)
*P. canaliculatum (Muhl.) Pursh. Giant Solomon's-Seal. Clarkestown. (H)
P. pubescens (Willd.) Pursh. Hairy Solomon's-Seal. General. (H)

Convallaria

*Convallaria majalis L. Lily-of-the-Valley. Ramapo. (H)

Medeola

Medeola virginiana L. Indian Cucumber-Root. General.

Trillium

Trillium cernuum L. Nodding Trillium. Ramapo, Clarkestown. (H)
T. erectum L. Purple Trillium. Ramapo, Clarkestown, Haverstraw. (H)

Smilax

*Smilax glauca Walt. var. leurophylla Blake. Glaucous-leaved Greenbrier. Orangetown, Ramapo.
S. herbacea L. Carrion-flower. Ramapo, Clarkestown. (H)
S. rotundifolia L. Catbrier. General.

DIOSCOREACEAE

Dioscorea

Dioscorea villosa L. Wild Yam. Ramapo, Clarkestown. (H)

AMARYLLIDACEAE

Hypoxis

Hypoxis hirsuta (L.) Coville. Yellow Star Grass. General. (H)

IRIDACEAE

BELAMCANDRA

BELAMCANDRA CHINENSIS (L.) DC. Blackberry-Lily. Clarkestown. (H)

SISYRINCHIUM

SISYRINCHIUM ANGUSTIFOLIUM Mill. Stout Blue-eyed Grass. General. (H)

IRIS

*IRIS PSEUDACORUS L. Yellow Iris. Clarkestown. Fully naturalized. (H)
I. VERSICOLOR L. Blue Flag. General. (H)

ORCHIDACEAE

CYPRIPEDIUM

CYPRIPEDIUM ACAULE Ait. Moccasin Flower. General. The most common orchid in the County. (H)
C. CALCEOLUS L. var. PUBESCENS (Willd.) Correll. Large Yellow Lady's-Slipper. Ramapo, Clarkestown. (H)

HABENARIA

*HABENARIA CLAVELLATA (Michx.) Spreng. Green Woodland Orchis. Stony Point. A single station. (H)
H. LACERA (Michx.) Lodd. Ragged Orchid. Ramapo, Clarkestown. (H)

POGONIA

POGONIA OPHIOGLOSSOIDES (L.) Ker. Rose Pogonia. Haverstraw. A single station. (H)

ISOTRIA

ISOTRIA VERTICILLATA (Willd.) Raf. Whorled Pogonia. Ramapo, Haverstraw. (H)

CALOPOGON

*CALOPOGON PULCHELLUS (Salis.) R. Br. Grass-Pink. Ramapo. Both stations have since been destroyed. (H)

SPIRANTHES

SPIRANTHES CERNUA (L.) Richard. Nodding Ladies'-Tresses. Ramapo. (H)
S. GRACILIS (Bigel.) Beck. Southern Slender Ladies'-Tresses. Ramapo. (H)

GOODYERA

GOODYERA PUBESCENS (Willd.) R. Br. Downy Rattlesnake-Plantain. Ramapo, Clarkestown, Orangetown. (H)

CORALLORHIZA

CORALLORHIZA MACULATA Raf. Spotted Coral-Root. Ramapo. (H)

LIPARIS

*LIPARIS LILIFOLIA (L.) Richard. Lilia-leaved Twayblade. Ramapo. (H)
*L. LOESELII (L.) Richard. Loesel's Twayblade. Stony Point. (H)

(to be continued)

FIELD TRIP REPORTS

July 28. Ashokan Reservoir Area. Joint trip with John Burroughs Natural History Society and Eastern New York Botanical Club. The group drove up the Watson Hollow road to the summit of the pass leading to Sundown and parked. All botanizing was

confined to the gorge at, or just below the source of the Rondout Creek. Although the altitude was only about 1600 ft. there was a large number of species of plants characteristic of more northern regions or of a higher altitude. The children found some ice beneath large rocks at the base of the steep slopes. Some of the more interesting plants were: *Aconitum noveboracense, Streptopus roseus* and *S. amplexifolius, Linnaea borealis, Cornus canadensis, Gaultheria hispidula, Pyrus* (*Sorbus*) *americana* and *P. decora, Abies balsamea, Polystichum Braunii, Actaea rubra* and *A. pachypoda.* Several beautiful spikes of purple-fringed orchis inspired a lively discussion as to which species. Mr. Hand called it *Habenaria fimbriata.* A *Viburnum* found in the gorge, at first thought to be *Opulus,* proved on later examination, to be *V. edule.*

Although birds were inconspicuous, the following observations were made: 2 turkey vultures, 2 buteos (sp?), Canada warbler, winter wrens. A junco flew up exposing a nest with 4 eggs on the ground among the mosses. Those interested in mosses and mushrooms gathered a goodly harvest which, we trust, yielded them valuable specimens. Attendance 37. Leader, Henry F. Dunbar.

August 12. Latourette Park, S. I. Cardinal flower, *Lycopodium adpressum, Polygala viridescens, Rhus vernix* and Persimmon trees were seen. Many Blackberries were enjoyed by the group. Attendance 13. Leader, Mathilde P. Weingartner.

Sept. 8. Ward's Point, S. I. *Salsola kali, Iva frutescens, Cakile edentula, Bidens trichosperma, Bidens bipinnata* were common flowers seen, while gull, mallard, knot and piping plover were the representative avian life of the day. Attendance 8. Leader, Mathilde P. Weingartner.

Sept. 9. Island Beach State Park, N. J. The trip included a hike through the large forested area near the north end of the Park, visits to dune areas showing different degrees of stability, and a drive to the southern end of the road about a mile from Barnegat Inlet.

The forest area is composed mostly of pine-oak groves and thickets of various species interspersed in a matrix of Hudsonia heath. Possibly younger but more nearly closed areas of the forest are composed mostly of red cedar, holly, and Balm of Gilead (*Populus gileadensis*). The latter was introduced about 50 years ago and has become locally conspicuous since that time.

Dune areas characterized by many blowouts were compared with areas characterized by a relatively stable dune ridge. The vegetation immediately inland of the unstable areas was found to be a rich mosaic of dune grass, Hudsonia, and low thickets of many species including poison ivy and greenbrier. In areas where there are few blowouts and the dune ridge is relatively unbroken, low thicket develops on the backslopes of the dunes almost to the crest and inland in a dense, nearly continuous mass. This situation implies that blowouts and general dune instability play an important part in maintaining the general diversity of the vegetation, and that the artificial stabilization of the dune ridge might result eventually in the more widespread occurrence of a rather monotonous thicket type of vegetation. Attendance 25. Leader, William G. Martin.

Sept. 16. Lebanon State Forest, New Jersey. Three oak hybrids, ×*Quercus heterophylla,* × *Q. saulii* and ×*Q. brittonii* were observed. A discussion of their presumed parents led to the conclusion that there might be many more unidentified oak hybrids in New Jersey. The presence in New Jersey of the parents of 28 possible hybrids which have been found in nearby states calls for a more thorough investigation of our flora.

Several plantings of seedling *Pinus rigida* designed to study deer browsing effects and one 660 tree planting of hybrid pines, *Pinus thunbergii* × several other Asiatic pines as parents, were seen near Mt. Misery. A *P. rigida* stump sprouting study started two years ago in the same area revealed that the most numerous and vigorous sprouts originated from trees 20 to 30 years old.

The final stop of the field trip was near Warren Grove at an old field stand of *P. echinata* surrounded on three sides by water. The stand contained 13,000 board feet per acre. This volume at 80–90 years indicates what can be grown on Pine Barrens soils if uncontrolled forest fires are eliminated. Attendance 5. Leaders, David Fairbrothers and John W. Andresen.

BOOK REVIEW

The Student's Flora of Tasmania. Part 1. By Winifred M. Curtis. xlvii + 234 pages, 63 text figures. Hobart, Tasmania. Government Printer. 6″ × 9¾″, quarter bound. 1956. 14 shillings (Australian).

The first installment of this fine new manual of what is to this reviewer one of the botanically most fascinating corners of the earth, should be of interest to every student of plant distribution. Its immediate predecessor is the "Tasmanian Flora" published in 1903 by Leonard Rodway. That included ferns and some 1200 flowering plants. The present book will add some 250 introduced and 100 native species to Rodway's total.

Dr. Curtis' manual is excellently illustrated with her own skillful line drawings. It contains a glossary with illustrative figures, a key to the 94 Dicot families represented in Tasmania, keys to the genera and species, and full descriptions of all families, genera, and species. The range both within and outside Tasmania is given for each, so far as known. The families are arranged in accordance with the Bentham and Hooker system.

This first portion of the projected three-volume work covers 41 families, beginning with Podocarpaceae and including Myrtaceae. The largest families within this range are Cruciferae, Caryophyllaceae, and Leguminosae—all with many adventive species—and Myrtaceae. The largest genera are *Eucalyptus*, *Acacia*, *Ranunculus*, *Pultnaea* (Leguminosae), *Hibbertia* (Dilleniaceae), *Drosera*, and *Leptospermum*, if introduced species are excluded. Some 160 species are listed as introductions, most of them from Eurasia.

A rough count shows that of the indigenous plants, approximately 75 are endemic to Tasmania, 185 occur also in one or several parts of the Australian mainland, about 28 reach New Zealand, and 20 occur beyond New Zealand, several of them supposedly cosmopolitan. There are affinities also with temperate South America, but these are predominantly at the family and generic, rarely the specific level. Six monotypic endemic genera are listed: *Microcachrys* (Podocarpaceae), *Diselma* (Cupressaceae), *Athrotaxis* (Taxodiaceae), *Acradenia* (Rutaceae), *Anodopetalum* (Cunoniaceae), and *Tetracarpaea* (Escalloniaceae).

These few figures should serve to indicate the strong Australian affinities of the flora, its secondary connection with that of New Zealand, its strongly endemic cast, and the increasingly important role played by adventive species.

Miss Curtis writes that she is "continuing on the same lines with Part II (completion of the Dicotyledons). I shall welcome any suggestions for improvements in this and in Part III." Thus far, I have not been able to think of any.—LINCOLN CONSTANCE, University of California, Berkeley.

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COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITORS OF THE TAXONOMIC INDEX

TAXONOMY, PHYLOGENY AND FLORISTICS

ALGAE

Blum, John L. Zygnemataceae of western New York. I. Pap. Mich. Acad. **41**: 3–19. 1956.

Nielsen, C. S. & Madsen, Grace C. Florida Scytonemataceae. II. Am. Midl. Nat. **56**: 116–125. Jl [O] 1956.

Papenfuss, George F. On the nomenclature of some Delesseriaceae. Taxon **5**: 158–162. S–O 1956.

Schumacher, George J. A qualitative and quantitative study of the plankton algae of southwestern Georgia. Am. Midl. Nat. **56**: 88–115. Jl [O] 1956.

BRYOPHYTES

Bryan, Virginia S. Chromosomes and systematic position of the inoperculate mosses, *Pleuridium* and *Bruchia*. Am. Jour. Bot. **43**: 460–468. Jl [5 O] 1956.

FUNGI

(See also under Morphology: **Drechsler; Kao**)

Bakerspigel, Alexander. *Endogone* in Saskatchewan and Manitoba. Am. Jour. Bot. **43**: 471–475. Jl [50] 1956.

Bakerspigel, A. *Haplosporangium* in Saskatchewan rodents. Mycologia **48**: 568–572. Au 1956.

Cain, Roy F. Studies of coprophilous Ascomycetes. II. *Phaeotrichum*, a new cleistocarpous genus in a new family, and its relationships. Canad. Jour. Bot. **34**: 675–687. III. The genus *Triangularia*. 689–698. *pl. 1–4*. IV. *Tripterospora*, a new cleistocarpous genus in a new family. 699–710. Jl 1956.

Cummins, George B. Nomenclatural changes for some North American Uredinales. Mycologia **48**: 601–608. Au 1956.

Ervin, Marion D. A new genus [*Gloeotromera*] of the Tremellaceae. Mycologia **48**: 690–693. O 1956.

Fuentes, César A. A new species [*nanum*] of *Microsporum*. Mycologia **48**: 613, 614. Au 1956.

Garner, J. H. B. Gasteromycetes from Panama and Costa Rica. Mycologia **48**: 757–764. O 1956.

Hale, Mason E. Chemical strains of the lichen *Parmelia furfuracea*. Am. Jour. Bot. **43**: 456–459. Jl [5 O] 1956.

Johnson, T. W. Marine fungi. I. *Leptosphaeria* and *Pleospora*. Mycologia **48**: 495–505. Au 1956.

Karling, John S. Development of *Synchytrium innominatum* in relation to other similar species. Mycologia **48**: 534–546. Au 1956.

Karling, John S. Unrecorded hosts and species of *Physoderma*. Bull. Torrey Club **83**: 292–299. 20 Au 1956.

Korf, Richard P. *Dalcomyces, Durandiomyces*, and other sparassoid forms of operculate Discomycetes. Mycologia **48**: 711–718. O 1956.

Korf, Richard P. Nomenclatural notes. I. Misuse of neotypes for *Venturia* and *Phaeosphaerella*. Mycologia **48**: 591–598. Au 1956.

Leppik, E. E. Some viewpoints on the phylogeny of rust fungi. II. *Gymnosporangium*. Mycologia **48**: 637–654. O 1956.

Limber, Donald P. A note on *Sporonema pulvinatum* Shear. Mycologia **48**: 612, 613. Au 1956.

Lowe, Josiah L. & Lundell, Seth. The identity of *Polyporus trabeus* Rostk. Pap. Mich. Acad. **41**: 21–26. 1956.

Mains, E. B. North American species of the Geoglossaceae. Tribe Cudonieae. Mycologia **48**: 694–710. O 1956.

Morris, Everett F. Tropical Fungi Imperfecti. Mycologia **48**: 728–737. O 1956.

Parmelee, J. A. The identification of the *Curvularia* parasite of gladiolus. Mycologia **48**: 558–567. Au 1956.

Routien, John B. A slime mold in an unusual habitat. Mycologia **48**: 612. Au 1956.

Savile, D. B. O. & Parmelee, J. A. Some fungal parasites of Portulacaceae [new sp., subsp., vars.]. Mycologia **48**: 573–590. Au 1956.

Singer, Rolf. *Boletus luridus* in North America. Mycologia **48**: 768, 769. O 1956.

Singer, Rolf. New genera of fungi. VII. Mycologia **48**: 719–727. O 1956.

Sparrow, F. K. Observations on chytridiaceous parasites of phanerogams. V. The occurrence of *Physoderma butomi* and *P. vagans* in the United States. Mycologia **48**: 765, 766. O 1956.

Sprague, Roderick. Some leafspot fungi on western Gramineae. X. [sp. nov. in *Cylindrosporium, Phyllosticta.*] Mycologia **48**: 741–756. O 1956.

Steyaert, R. L. A reply and an appeal to Professor Guba [on *Monochaetia*]. Mycologia **48**: 767, 768. O 1956.

Yerkes, William D. *Chaetoseptoria wellmanii* in Mexico. Mycologia **48**: 738–740. O 1956.

PTERIDOPHYTES

(See also under Morphology: **Marengo**)

Brooks, Karl L. Notes on the pteridophytes of Delaware County, New York. Am. Fern Jour. **46**: 109–121. Jl–S [O] 1956.

Crane, Fern Ward. Spore studies in *Dryopteris*, III. Am. Fern Jour. **46**: 127–130. Jl–S [O] 1956.

DeVol, Charles E. *Ceratopteris deltoidea* disappears from the type locality. Am. Fern Jour. **46**: 131–133. Jl–S [O] 1956.

Rossignol, Gilbert R. *Ophioglossum tenerum* in Georgia. Am. Fern Jour. **46**: 107. Jl–S [O] 1956.

Smith, Jesse F. *Lygodium palmatum* vs. urbanization. Rhodora **58**: 270, 271. S [O] 1956.

Tryon, Rolla. A revision of the American species of *Notholaena*. Contr. Gray Herb. **179**: 1–106. 1 O 1956.

Wagner, Warren H. & Lord, Lois P. The morphological and cytological distinctness of *Botrychium minganense* and *B. lunaria* in Michigan. Bull. Torrey Club **83**: 261–280. 20 Au 1956.

SPERMATOPHYTES

(See also under Morphology: **Dore**; under Genetics: **Mirov**)

Allard, H. A. & Leonard, E. C. Some vascular plants collected in and near the township of Oxford, Worcester County, Massachusetts. Castanea **21**: 125–128. S 1956.

Bailey, I. W. The relationship between *Sphenostemon* of New Caledonia and *Nouhuysia* of New Guinea. Jour. Arnold Arb. **37**: 360–365. 15 O 1956.

Baker, William H. Plants of Iron Mountain, Rogue River range, Oregon. Am. Midl. Nat. **56**: 1–53. Jl [O] 1956.

Buchinger, Maria. Sinopsis preliminar de las especies argentinas del género *Polygonum* L. Bol. Soc. Argent. Bot. **6**: 98–106. Au 1956.

Bunting, George S. "Clave de los géneros de las aráceas de Venezuela." Bol. Soc. Venez. Ci. Nat. 7^{85}: 71–79. 1956.

Cabrera, Angel Lulio. Cuatro especies nuevas del género *Verbesina* (Compositae) de América del Sur. Notas Mus. La Plata Bot. 18^{88}: 59–70. 18 Jl 1955.

Cabrera, Angel Lulio. Notas sobre los *Senecio* sudamericanos VIII. Notas Mus. La Plata Bot. 18^{89}: 191–240. 23 Au 1955.

Cabrera, Angel Lulio. Nueva especies argentinas del género *Schinus* (Anacardiaceae). Notas Mus. La Plata Bot. 18^{87}: 27–31. 5 Jl 1956.

Cabrera, Angel Lulio. Un nuevo género de eupatorieas (Compositae) de Bolivia. Bol. Soc. Argent. Bot. **6**: 91–93. Au 1956.

Cárdenas, Martin. New Bolivian cacti—part 4 [sp. nov. in *Echinopsis, Opuntia*]. Cactus & Succ. Jour. **28**: 110–114. Jl–Au [Je] 1956.

Case, Frederick W. Some Michigan records for *Sarracenia purpurea* forma *heterophylla*. Rhodora **58**: 203–207. 29 Au 1956.

Correa, Maevia Noemi. Las especies argentinas del género *Gavilea*. Bol. Soc. Argent. Bot. **6**: 73–86. Au 1956.

Cuatrecasas, José. Moráceas nuevas de Colombia. Caldasia 7^{34}: 287–304. 15 Au 1956.

Cuatrecasas, José. Notas a la flora de Venezuela. Bol. Soc. Venez. Ci. Nat. 7^{85}: 80–97. 1956.

Cuatrecasas, José & Aristeguieta, Leandro. El género *Hinterhubera* Weddell. Bol. Soc. Venez. Ci. Nat. 7^{86}: 98–104. 1956.

Cuevas Aleman, Baltasar. Las dalias. Soc. Bot. Méx. Bol. **19**: 21, 22. Jl 1956.

Cutler, Hugh C. & Whitaker, Thomas W. *Cucurbita mixta*, Pang. Its classification and relationships. Bull. Torrey Club **83**: 253–260. Au 1956.

Davis, P. A. Type location of *Shortia galacifolia*. Castanea **21**: 107–113. S 1956.

Dugand, Armando. Algunas plantas leñosas del Trapecio Amazónico colombiano. Caldasia 7^{34}: 305–315. 15 Au 1956.

Dunn, David B. The lupines collected by David Douglas from 1825 to 1827: their type localities and nomenclature. Leafl. West. Bot. **8**: 47–54. 28 Au 1956.

Erskine, J. S. Additions to the flora of St. Paul Island, Nova Scotia. Rhodora **58**: 245–249. S [O] 1956.

Ferreyra, Ramón. Nuevas especies de *Nolana* del Peru. Publ. Mus. Nac. Mayor San Marcos Bot. B. **10**: 1–15. *pl. 1–10*. D 1955.

Garay, Leslie A. Studies in American orchids. II. The genus *Brachionidium* Lindl. Canad. Jour. Bot. **34**: 721–743. Jl 1956.

Grant, Verne. The influence of breeding habit on the outcome of natural hybridization in plants. Am. Nat. **90**: 319–322. S 1956.

Herriott, Lillian & Noldeke, Anita M. A numerical summary of the vascular plants of California. Leafl. West. Bot. **8**: 58, 59. 28 Au 1956.

Herter, W. G. Flora del Uruguay IX/X. Revista Sudam. Bot. **9**: 245–280. Au 1956.

Hertrich, Wm. Genus *Pereskia* (Tribe 1. Pereskieae) of the family Cactaceae. Cactus & Succ. Jour. **28**: 108, 109. Jl–Au [Je] 1956.

Howard, Richard A. Studies in the genus *Coccoloba*, II. The identification of *Coccoloba swartzii* Meisner and *Coccoloba barbadensis* Jacquin and their relatives. Jour. Arnold Arb. **37**: 317–339. 15 O 1956.

Howell, J. T. *Chenopodium nevadense* in California. Leafl. West. Bot. **8**: 46. 28 Au 1956.

Howell, J. T. Lyall's leafy *Aster* in California. Leafl. West. Bot. **8**: 46. 28 Au 1956.

Howell, John Thomas. The numerical summary of Californian plants and endemism. Leafl. West. Bot. **8**: 59, 60. 28 Au 1956.

Hutchison, P. C. Icones plantarum succulentarum. 1. *Adromischus hallii* P. C. Hutchison. Cactus & Succ. Jour. **28**: 144–147. O 1956.

Iltis, Hugh H. Studies in Virginia plants II. *Rhododendron maximum* in the Virginia coastal plain and its distribution in North America. Castanea **21**: 114–124. S 1956.

Jacobsen, H & Rowler, G. D. Some name changes in succulent plants—part III. Nat. Cact. & Succ. Jour. **11**: 59–61. S 1956.

Kimnach, Myron & Hutchison, P. C. Icones plantarum succulentarum. 2. *Werckleocereus imitans* Kimnach and Hutchison. Cactus & Succ. Jour. **28**: 152–156. O 1956.

Lasser, Tobias, Penny, John S. & Marsh, Vernon L. Aspectos de la vegetación de la parte occidental de la cuenca del Lago de Maracaibo. Bol. Soc. Venez. Ci. Nat. **17**[88]: 47–70. 1956.

Löve, Áskell & Löve, Drois. Chromosomes and taxonomy of eastern North American *Polygonum*. Canad. Jour. Bot. **34**: 501–521. Jl 1956.

McClintock, Elizabeth. New combinations in *Hydrangea*. Jour. Arnold Arb. **37**: 373, 374. 15 O 1956.

McVaugh, Rogers. Nomenclatural notes on Myrtaceae and related families. Taxon **5**: 133–147. Au. 162–167. S–O 1956.

Maguire, Bassett. Distribution, endemicity, and evolution patterns among Compositae of the Guayana Highland of Venezuela. Proc. Am. Philos. Soc. **100**: 467–475. 15 O 1956.

Maguire, Bassett & Barneby, R. C. A new species of *Arenaria* [*Rosei*]. Leafl. West. Bot. **8**: 55–57. 28 Au 1956.

Martínez Crovetto, R. Especies nuevas o críticas del género *Apodanthera* (Cucurbitaceae) II. Bol. Soc. Argent. Bot. **6**: 94–97. Au 1956.

Matuda, Eizi. Dos nuevos *Anthurium* de Chiapas. Soc. Bot. Méx. Bol. **19**: 19–21. Jl 1956.

Menninger, Emma D. One hundred years of orchid hybridization. Am. Orchid Soc. Bull. **25**: 667–678. O 1956.

Moldenke, H. N. Materials toward a monograph of the genus *Vitex*, VI. Phytologia **5**: 404–464. O 1956.

Monachino, Joseph. The sarmentogeniferous variety of *Strophanthus sarmentosus*. Bull. Torrey Club **83**: 281–288. Au 1956.

Moore, Dwight Minson. *Neviusia alabamensis* in Arkansas. Rhodora **58**: 187–191. Jl [6 Au] 1956.

Rollins, Reed C. On the identity of *Lesquerella angustifolia*. Rhodora **58**: 199–202. Au [S] 1956.

Rubtzoff, Peter. *Aponogeton distachyus* in San Mateo County, California. Leafl. West. Bot. **8**: 60. 28 Au 1956.

Ruiz Leal, Adrian. Una nueva especie argentina del género *Struthanthus* (Loranthaceae). Bol. Soc. Argent. Bot. **6**: 87–90. Au 1956.

Ruiz Leal, Adrian. Una variedad argentina nueva de *Phrygilanthus verticillatus* (Loranthaceae). Bol. Soc. Argent. Bot. **6**: 110–115. Au 1956.

Sherff, Earl Edward. Some recently collected dicotyledonous Hawaiian Island and Peruvian plants. Am. Jour. Bot. **43**: 475–478. Jl [O] 1956.

Shinners, Lloyd H. *Andropogon Ischaemum* L., var. *songaricus* Ruprecht: technical name for King Ranch bluestem. Field & Lab. **24**: 101–103. Je [7 O] 1956.

Shinners, Lloyd H. The Texas species of *Limonium* (Plumbaginaceae). Field & Lab. **24**: 105, 106. Je [70] 1956.

Smith, L. B. Notes on Bromeliaceae, VIII. Phytologia **5**: 401–403. *pl. 1.* O 1956.

Sparre, Benkt. Un *Potamogeton* nuevo de Chile: *Potamogeton reniacoensis*. Bol. Soc. Argent. Bot. **6**: 107–109. Au 1956.

Stebbins, G. Ledyard. Taxonomy and the evolution of genera, with special reference to the family Gramineae. Evolution **10**: 235–245. S 1956.

Tamayo, Francisco. Contribución al estudio de la flora llanera (Estado Guárico). Bol. Soc. Venez. Ci. Nat. **7**^{55}: 105–134. 1956.

Twisselmann, Ernest C. The field occurrence of *Howelliella*. Leafl. West. Bot. **8**: 57, 58. 28 Au 1956.

Uribe-Uribe, Lorenzo. Sertula florae Colombiae, III. Caldasia **7**^{34}: 279–286. 15 Au 1956.

Webster, D. H. Notes on the distribution of *Potamogeton* species and hybrids in Nova Scotia. Proc. Nova Scotian Inst. **24**: 16–24. Jl 1956.

Yuncker, T. G. Additions to the Fijian species of *Peperomia*. Bull. Torrey Club **83**: 300–304. Au 1956.

PALEOBOTANY

Flint, Richard Foster. New radiocarbon dates and Late Pleistocene stratigraphy. Am. Jour. Sci. **254**: 265–287. My 1956.

ECOLOGY AND PLANT GEOGRAPHY

Bentley, P. A. & Smith, E. C. The forests of Cape Breton in the seventeenth and eighteenth centuries. Proc. Nova Scotian Inst. **24**: 1–15. Jl 1956.

Coleman, Babette Brown, Muenscher, Walter C. & Charles, Donald R. A distributional study of the epiphytic plants of the Olympic Peninsula, Washington. Am. Midl. Nat. **56**: 54–87. Jl [O] 1956.

Murdock, J. R. & Richard, W. H. The relationship of soil moisture and temperature among certain grassland associations of southeastern Washington. Northw. Sci. **30**: 99–103. Au [S] 1956.

Potzger, J. E. & Courtemanche, Albert. A series of bogs across Quebec from the St. Lawrence valley to James Bay. Canad. Jour. Bot. **34**: 473–500. Jl 1956.

MORPHOLOGY

(including anatomy and cytology in part)

Andresen, John W. A large swamp white oak of the lower Raritan flood plain. Bull. Torrey Club **83**: 382–385. O 1956.

Ball, Ernest. Growth of the embryo of *Ginkgo biloba* under experimental conditions. I. Origin of the first root of the seedling in vitro. Am. Jour. Bot. **43**: 488–495. Jl [O] 1956.

Barr, Margaret E. The development of the ascocarp in *Phacotrichum hystricinum*. Canad. Jour. Bot. **34**: 563–568. Jl 1956.

Dore, William G. Some grass genera with liquid endosperm. Bull. Torrey Club **83**: 335–337. O 1956.

Drechsler, Charles. Supplementary developmental stages of *Basidiobolus ranarum* and *Basidiobolus haptosporus*. Mycologia **48**: 635–676. O 1956.

Hrushovetz, S. B. Cytological studies of ascus development in *Cochliobolus sativus*. Canad. Jour. Bot. **34**: 641–651. *pl. 1–3*. Jl 1956.

Johnson, Marion A. & Truscott, Frederick H. On the anatomy of *Serjania*. I. Path of the bundles. Am. Jour. Bot. **43**: 509–518. Jl [O] 1956.

Kao, C. J. The cytology of *Syzygospora alba*. Mycologia **48**: 677–684. O 1956.

LaCroix, J. D. & Guard, A. T. Morphological and histological modifications of pine seedlings induced by petroleum naphtha. Canad. Jour. Bot. **34**: 621–627. Jl 1956.

Leppik, E. E. The form and function of numeral patterns in flowers. Am. Jour. Bot. **43**: 445–455. Jl [O] 1956.

Marengo, Norman E. The microscopic structure of the mature spores of the sensitive fern, the ostrich fern, and the royal fern. Am. Fern Jour. **46**: 97–104. Jl–S [O] 1956.

Muzik, Thomas J. & Cruzado, Hector J. Formation and rooting of adventitious shoots in *Hevea brasiliensis*. Am. Jour. Bot. **43**: 503–508. Jl [O] 1956.

Orton, C. R. The morphology and life history of *Phyllachora punctum*. Phytopathology **46**: 441–444. Au 1956.

Periasamy, K. & Swamy, B. G. L. The conduplicate carpel of *Cananga odorata*. Jour. Arnold Arb. **37**: 366–372. 15 O 1956.

Rahn, Joan Elma. A study of the three-dimensional configurations of sporogenous cells in the anthers of *Trillium erectum* L. with special reference to the geometrical aspects of cell shape. Bull. Torrey Club **83**: 355–376. O 1956.

Rosinski, Martin A. Development of the ascocarp of *Anthracobia melaloma*. Mycologia **48**: 506–533. Au 1956.

Stork, Harvey E. Epiphyllous flowers. Bull. Torrey Club **83**: 338–341. O 1956.

GENETICS

(including cytogenetics)

(See also under Spermatophytes: **Grant**; under Morphology: **Hrushovetz**)

Allard, R. W. The analysis of genetic-environmental interactions by means of diallel crosses [applied to *Nicotiana*]. Genetics **41**: 305–318. My [Je] 1956.

Carnahan, H. L. & Hill, Helen D. Cytogenetics of progenies of 35-chromosome reed canary grass (*Phalaris arundinacea* L.). Agron. Jour. **48**: 356–359. Au 1956.

Dodge, B. O. New hybrid asci by intercrossing lethal mutant races of *Neurospora tetrasperma*. Compt.-Rend. Lab. Carlsb. Physiol. **26**: 51–69. 14 My 1956.

Gilles, A., Devreux, M. & Lhoas, P. Recherches cytogénétiques sur les *Solanum*, section *Tuberarium*. III. Polyploidisation expérimentale. Genetica **28**: 42–50. IV. Action des rayons X sur *Solanum acaule*. 51–63. 1956.

Greenleaf, W. H. Inheritance of resistance to tobacco-etch virus in *Capsicum frutescens* and in *Capsicum annuum*. Phytopathology **46**: 371–375. Jl 1956.

Hanson, C. H. & Cope, W. A. A dwarf mutation in sericea lespedeza. Jour. Hered. **47**: 155, 156. Jl–Au [S] 1956.

Jones, Guy L. & Ausemus, E. R. Inheritance of the mode of reaction to stem rust, particularly race 15B, and leaf rust in two crosses of vulgare wheats. Agron. Jour. **48**: 435–439. O 1956.

Lesins, Karlis. Somatic flower color mutations in alfalfa. Jour. Hered. **47**: 171–179. Jl–Au [S] 1956.

Lindegren, Carl C. *et al.* Genetical analysis of the clones from a single tetrad of *Saccharomyces* showing non-Mendelian segregation. Genetica **28**: 1–24. 1956.

Miles, Philip G. & Raper, John R. Recovery of the component strains from dikaryotic mycelia [of Basidiomycetes]. Mycologia **48**: 484–494. Au 1956.

Mirov, N. T. Composition of turpentine of lodgepole × jack pine hybrids. Canad. Jour. Bot. **34**: 443–457. Jl 1956.

Ogur, Maurice & St. John, Ralph C. Demonstration by cellular nitrogen and turbidity of the haploid state of the four clones of yeast derived from an irregularly segregating locus. Genetica **28**: 25, 26. 1956.

Oldemeyer, Robert K. Inheritance of the white seed character in alfalfa. Agron. Jour. **48**: 449–451. O 1956.

Pittenger, Thad H. & Atwood, K. C. Stability of nuclear porportions during growth of *Neurospora* heterokaryons. Genetics **41**: 226–241. Mr [My] 1956.

Pittman, David D. & Pedigo, Paul R. Demonstration by X-ray inactivation of the haploid state of the four clones of yeast derived from an irregularly segregating ascus. Genetica **28**: 27–30. 1956.

Schuler, Josef F. & Sprague, G. F. Natural mutations in inbred lines of maize and their heterotic effect. II. Comparison of mother line vs. mutant when outcrossed to unrelated inbreds. Genetics **41**: 281–289. Mr [My] 1956.

Shult, Ernest E. & Lindegren, Carl C. Mapping methods in tetrad analysis. I. Provisional arrangement and ordering of loci preliminary to map construction by analysis of tetrad distribution. Genetica **28**: 165–176. 1956.

Simons, M. D. The genetic basis of the crown rust resistance of the oat variety Ascencao. Phytopathology **46**: 414–416. Au 1956.

Swarup, Vishnu *et al.* A cytogenetic analysis of reactions to wheat streak-mosaic virus in certain agrotricum hybrids. Agron. Jour. **48**: 374–379. Au 1956.

Thomas, W. I. & Johnson, I. J. Inheritance of pollen restoration and transmission of cytoplasmic sterility in popcorn. Agron. Jour. **48**: 472–474. O 1956.

Thurman, R. L. & Henderson, M. T. The inheritance of lint density index in American upland cotton. Agron. Jour. **48**: 344–347. Au 1956.

Unrau, John, Person, Clayton & Kuspira, John. Chromosome substitution in hexaploid wheat. Canad. Jour. Bot. **34**: 629–640. Jl 1956.

Wilson, G. B. & Alexopoulos, Const. J. Spontaneous mutation in *Gelasinospora calospora*, a homothallic fungus. Mycologia **48**: 685–689. O 1956.

Wilson, S. M., Daniel, Arlyn & Wilson, G. R. Cytological and genetical effects of the defoliant endothal. Jour. Hered. **47**: 150–155. Jl–Au [S] 1956.

PLANT PHYSIOLOGY

(See also under Morphology: **LaCroix & Guard**)

Armolik, N. & Dickson, J. G. Minimum humidity requirement for germination of conidia of fungi associated with storage of grain. Phytopathology **46**: 462–465. Au 1956.

Ashton, Floyd M. Effects of a series of cycles of alternating low and high soil water contents on the rate of apparent photosynthesis in sugar cane. Plant Physiol. **31**: 266–274. Jl [S] 1956.

Barnett, H. L. & Lilly, V. G. Factors affecting the production of zygospores by *Choanephora cucurbitarum*. Mycologia **48**: 617–627. O 1956.

Blackmon, Cyril W. & Mefferd, Roy B. *Sphacelotheca cruenta*. 2. Growth characteristics in synthetic media and oxidative metabolism. Phytopathology **46**: 403–407. Jl 1956.

Braun, Armin C. A study of the nature of autonomy in neoplastic plant cells. Am. Nat. **90**: 227–236. Au 1956.

Stover, R. H. Effect of nutrition on growth and chlamydospore formation in brown and gray cultures of *Thielaviopsis basicola*. Canad. Jour. Bot. **34**: 459–472. Jl 1956.

Stumpf, P. K. & Barber, George A. Fat metabolism in higher plants. VIII. β-oxidation of fatty acids by peanut mitochondria. Plant Physiol. **31**: 304–308. Jl [S] 1956.

Swanson, C. R. *et al.* Effect of 2,4-dichlorophenoxyacetic acid and other growth-regulators on the formation of a red pigment in Jerusalem artichoke tuber tissue. Plant Physiol. **31**: 315, 316. Jl [S] 1956.

Waggoner, Paul E. & Dimond, A. E. Polyphenol oxidases and substrates in potato and tomato stems. Phytopathology **46**: 495–497. S 1956.

Wallihan, E. F. & Heymann-Herschberg, L. Some factors affecting absorption and translocation of zinc in citrus plants. Plant Physiol. **31**: 294–299. Jl [S] 1956.

Ward, G. M. & Durkee, A. B. The peach replant problem in Ontario. III. Amygdalin content of peach tree tissues. Canad. Jour. Bot. **34**: 419–422. Jl 1956.

Warnock, Stephen J. & Hagedorn, D. J. Germination and storage of pea (*Pisum sativum* L.) pollen. Agron. Jour. **48**: 347–352. Au 1956.

Zachariah, Anna T. *et al.* The influence of environmental factors on cultural characters of *Fusarium* species. Mycologia **48**: 459–467. Au 1956.

PHYTOPATHOLOGY

(See also under Fungi: **Parmelee; under Genetics: Greenleaf; Jones & Ausemus; Simons; Swarup** *et al.*)

Armolik, N., Dickson, J. G. & Dickson, A. D. Deterioration of barley in storage by microorganisms. Phytopathology **46**: 457–461. Au 1956.

Baxter, J. W. *Cercospora* black stem of alfalfa. Phytopathology **46**: 398–400. Jl 1956.

Cherewick, M. J. & Cunningham, R. H. Further improvements in the partial-vacuum method of inoculation with loose smut fungi. Phytopathology **46**: 355–362. Jl 1956.

Cormack, M. W. & Moffatt, J. E. Occurrence of the bacterial wilt organism in alfalfa seed. Phytopathology **46**: 407–409. Jl 1956.

Crane, Paul L. Factors affecting resistance to *Pythium* seedling blight of maize incited by *Pythium ultimum*. Agron. Jour. **48**: 365–368. Au 1956.

Creelman, D. W. Spot-anthracnose [*Elsinoë tiliae*] of linden. Mycologia **48**: 552–557. Au 1956.

Critopoulos, P. Perpetuation of the brown rust of barley in Attica. Mycologia **48**: 596–600. Au 1956.

Fergus, Charles L. The influence of actidione on wood-staining fungi. Mycologia **48**: 468–472. Au 1956.

Freitag, J. H. Western aster yellows virus infection of squash, pumpkin, and cucumber. Phytopathology **46**: 323–326. Je 1956.

Grainger, John. Host nutrition and attack by fungal parasites. Phytopathology **46**: 446–456. Au 1956.

Grogan, R. G. & Zink, F. W. Fertilizer injury and its relationship to several previously described diseases of lettuce. Phytopathology **46**: 416–422. Au 1956.

Hildebrand, A. A. Observations on stem canker and pod and stem blight of soybeans in Ontario. Canad. Jour. Bot. **34**: 577–599. Jl 1956.

Holmes, Francis O. Elimination of foliage spotting from sweetpotato. Phytopathology **46**: 502–504. S 1956.

Hooker, A. L. Association of resistance to several seedling, root, stalk, and ear diseases in corn. Phytopathology **46**: 379–387. Jl 1956.

Krusberg, L. R. & Sasser, J. N. Host-parasite relationships of the lance nematode in cotton roots. Phytopathology **46**: 505–510. S 1956.

Lindberg, G. D., Hall, D. H. & Walker, J. C. A study of melon and squash mosaic viruses. Phytopathology **46**: 489–495. S 1956.

Lownsbery, B. F. *Pratylenchus vulnus*, primary cause of the root-lesion disease of walnuts. Phytopathology **46**: 376–379. Jl 1956.

Ludwig, R. A. *et al.* Studies on the seedling disease of barley caused by *Helminthosporium sativum* P. K. & B. Canad. Jour. Bot. **34**: 653–673. *pl. 1–4.* Jl 1956.

Murray, Hazel C. & Zscheile, F. P. Studies on the amino acid composition and nutrient requirements of the wheat bunt fungus. Phytopathology **46**: 363–366. Jl 1956.

Nelson, Paul E. & Wilhelm, Stephen. An undescribed fungus [*Idriella lunata*] causing a root rot of strawberry. Mycologia **48**: 547–551. Au 1956.

Parmeter, J. R., Kuntz, J. E. & Riker, A. J. Oak wilt development in bur oaks. Phytopathology **46**: 423–436. Au 1956.

Rubio, M. & Van Slogteren, D. H. M. Light and electron microscopy of X-bodies associated with broad-bean motile virus and *Phaseolus* virus 2. Phytopathology **46**: 401, 402. Jl 1956.

Schmidt, John W. *et al.* Range of reactions to wheat streak-mosaic virus in hybrids derived from *Triticum vulgare* × *Agropyron elongatum*. Agron. Jour. **48**: 371–373. Au 1956.

Sinclair, J. B. & Walker, J. C. Extent of cross protection among strains of cucumber mosaic virus in cucumber and cowpea. Phytopathology **46**: 366–371. Jl 1956.

Stace-Smith, Richard. Studies on *Rubus* virus diseases in British Columbia. III. Separation of components of raspberry mosaic. Canad. Jour. Bot. **34**: 435–442. *pl. 1.* Jl 1956.

Takeshita, R. M. Identity of the oat red-leaf virus with the barley yellow-dwarf virus. Phytopathology **46**: 436–440. Au 1956.

Vaartaja, Olli. Screening fungicides for controlling damping-off of tree seedlings. Phytopathology **46**: 387–397. Jl 1956.

Vaartaja, O. & Cram, W. H. Damping-off pathogens of conifers and of caragana in Saskatchewan. Phytopathology **46**: 391–397. Jl 1956.

Walter, James M. Combination of resistance to tobacco-etch and tobacco-mosaic viruses in tomato breeding stocks. Phytopathology **46**: 517–519. S 1956.

Walter, James M. Hereditary resistance to tobacco-mosaic virus in tomato. Phytopathology **46**: 513–516. S 1956.

GENERAL BOTANY
(including biography)

Alain, *Hermano.* Brother Leon (Joseph Sylvestre Sauget). Bull. Torrey Club **83**: 305–307. 20 Au 1956.

Bonar, Lee. Elizabeth Eaton Morse. Mycologia **48**: 439–442. Je 1956.

Crafts, A. S. Weed control; applied botany. Amer. Jour. Bot. **43**: 548–556. Jl [O] 1956.

Dexter, Ralph W. The early *American naturalist* as reviewed by letters to the founders. Am. Nat. **90**: 209–225. Au 1956.

Dupree, A. Hunter. Asa Gray and Andrew Jackson Downing: A bibliographic note. Rhodora **58**: 243–245. S [O] 1956.

Ewan, Joseph. E. D. Merrill. Jour. Wash. Acad. **46**: 267, 268. Au 1956.

Fuller, Harry J. The odor of botany. Am. Jour. Bot. **43**: 544–547. Jl [O] 1956.

Geiser, S. W. Heinrich Carl Beyrich in Arkansas Territory, 1834. Field & Lab. **24**: 77–96. Je [7 O] 1956.

Hansen, Walter W., Struble, F. Ben & Brunkerhoff, L. A. Fred Maas Rolfs, 1872–1956. Phytopathology **46**: 413. Au 1956.

Horsfall, James G. The fight with the fungi or the rusts and rots that rob us, the blasts and the blights which beset us. Am. Jour. Bot. **43**: 532–536. Jl [O] 1956.

McCormack, Jack. Botanical bibliographies: classification, form, arrangement and use. Bull. Torrey Club **83**: 377–381. S–O 1956.

[**Martin, G. W.,** *ed.*] Dr. W. A. Murrill. Mycologia **48**: 457, 458. Au 1956.

Peattie, Donald Culross. On the popularization of botany. Am. Jour. Bot. **43**: 520–525. Jl [O] 1956.

Rickett, H. W. Materials for a dictionary of botanical terms—IV. Terms to describe apices. Bull. Torrey Club. **83**: 342–354. S–O 1956.

Sinnott, Edmund W. Botany and morphogenesis. Am. Jour. Bot. **43**: 526–531. Jl [O] 1956.

Smith, Gilbert M. The role of study of algae in the development of botany. Am. Jour. Bot. **43**: 537–543. Jl [O] 1956.

Thomas, John H. Charles Piper Smith, 1877–1955. Leafl. West. Bot. **8**: 41–46. *port.* 28 Au 1956.

Voss, Edward G. & Wilson, James S. Clarance R. Hanes. Rhodora **58**: 272, 273. S [O] 1956.